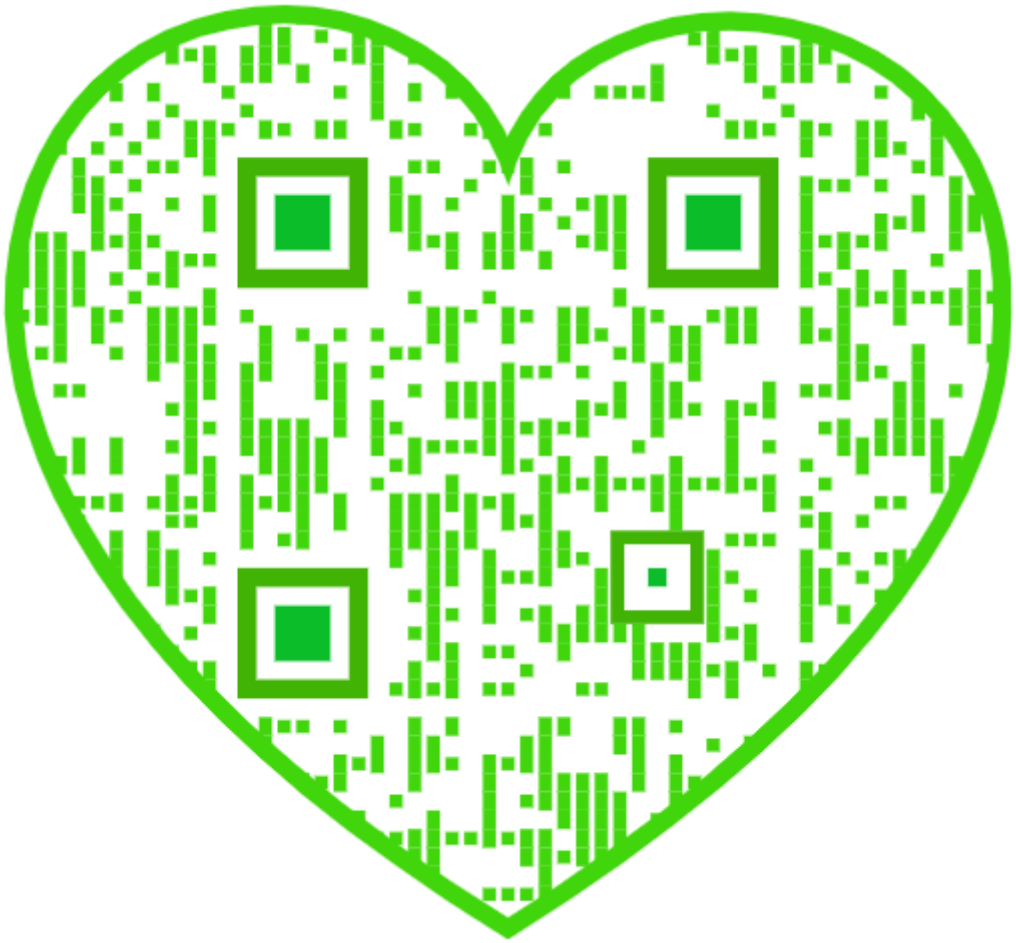
Univ. of
Toronto
Library



Water and Sewage Works

MUNICIPAL AND COUNTY ENGINEERING

INDEX

JANUARY—JUNE, 1919

VOLUME LVI

15-2966
24/10/19.

ENGINEERING PUBLISHING COMPANY
INDIANAPOLIS, INDIANA CHICAGO, ILLINOIS

Municipal and County Engineering

INDEX

VOL. LVI. JANUARY—JUNE, 1919.

Capital Letter E refers to Editorials.

American Association of Engineers Urges Chicago Mayor to Recommend Salary Increases for Engineers in City's Employ 9
American Association of Engineers, All Public Engineers Should Support.....149
American Association of Engineers, Will it Adopt Trade Union Methods? E....197
Asphalt Plant, How Equipped to Dispense With Two Men and Lower Cost, by M. R. Butler.....206
American Association of Engineers, How it Aided St. Louis Municipal Engineers 216

Bituminous Macadam Roads and Pavements, Design and Construction of, by A. W. Dean.....207
Bituminous Surfaces and Pavements Under Motor Truck Traffic, Efficiency of, by Prevost Hubbard..... 98
Blasting a Ditch Through a Swamp...226
Brick Highways of Ashtabula County, Ohio, by Ray N. Case..... 53
Brick, New Methods of Handling with Bodies Fitting Any Motor Truck..... 33
Brick Patents Sustained, Dunn Wire-Cut Lug 67
Brick Pavement, Failure Caused by Poor Brick, by C. C. Wiley.....179
Brick Pavements Constructed with Sand Cushions, Cement Mortar Beds and Green Concrete Foundation, Present Status of, by Maj. Wm. M. Acheson..103
Brick Paving, Monolithic Type, Latest Seattle Specifications for, by W. H. Tiedeman 13
Brick Road, Monolithic, South of Seneca, Ill., Design and Construction of, by A. H. Hunter.....161
Bridge, Proposed Eighteenth Street, Des Moines, Iowa..... 76
Bridges, Highway, Recommended Procedure in the Painting and Maintenance of, by Chas. E. Snead.....171
Business Press and the Newspapers, E..160

Cars, Tiltable, Automatic Device for Dumping and Righting.....196
Charging Bins, Portable, Road Contractor Successfully Employs, to Eliminate Dumping and Wheeling on Subgrade in Concrete Road Construction, by George A. Burley..... 11
Chlorination of Chicago's Water Supply, by John Ericson..... 6
Chlorination of Swimming Pool Water..231
Chlorine Treatment of London, England, Water Supply, Notes on..... 29
Chlorine Treatment, Successful in Removing Crenothrix from Public Water Supply, by W. F. Monfort.....182
City and County Engineers write of Construction Projects Planned to Provide Buffer Employment for Labor During Readjustment Period..... 37
Concrete, Cement, Use of Calcium Chloride Solution to Hasten Setting of.....208
Concrete Base for Wood Block Paving, Smooth Surfaced, Methods Employed in Constructing in Minneapolis, by Ellis R. Dutton..... 51
Concrete Highway from Rockwood to Monroe, Mich., Design and Construction of, by L. C. Smith.....163
Concerete in Roads, Bridges and Culverts, by H. Eltinge Breed.....222
Concrete Roads, Machine Finishing of, by E. G. Carr.....132
Concrete Roads, Some Points to Observe in the Construction of, by Wm. W. Cox 105
Concrete Road Construction, Road Contractor Successfully Employs Portable Charging Bins to Eliminate Dumping and Wheeling on Subgrade in, by George A. Burley..... 11
Concrete Sidewalks and Concrete Curb and Gutter at Street Intersections, design of, by W. Robt. Paige.....188
Concrete Shoulders to Preserve the Old Macadam Roads of Maryland, Building New, by John N. Mackall..... 79
Concrete Slabs at Railway Grade Crossings, Precast, Use of..... 34
Conservancy, Water Works, by Arthur A. Reimer 24
Construction Projects Planned to Provide Buffer Employment for Labor During Readjustment Period, City and County Engineers write of..... 37
Construction, Cheap, Resist Pressure for, E 197
Construction Season is Here, E..... 77
Contract, Cost-Plus-A-Fixed Fee, Advantages of on Building Construction, by A. E. Wells.....213
Contracting for Highway Work During the Reconstruction Period, Methods of, by John H. Gordon..... 110
Construction Work by New York State Highway Department 206
Contractors, Road, New York, Why Some Defaulted, E 197
Conveyor, Portable, for Handling Loose Bulk Materials, New Type.....186
Crenothrix, Methods of Removing from Public Water Supplies, by W. F. Monfort 182
Costs, Make Known in Self-Defense, E. 1
County Engineering Problem, A Modern, E. 120
County Highway Engineer-Manager, by E. E. Sours.....101
Culvert Form, One-Man Collapsible, Proves Successful in Actual Use.....196

Day Labor, Force Account Work and Bonuses on Highway Construction, by Charles M. Upham..... 31
Day Labor Municipal Construction Work in Flint, Mich., by Ezra C. Shoecraft. 66
Design of Roads, Rational, E..... 1
Dissolved Oxygen as an Index of the Pollution of New York Harbor, by Kenneth Allen 172
Dixie Highway from Rockwood to Monroe, Mich., Design and Construction of, by L. C. Smith.....163
Drainage District Advocated as Solution of the Mahoning River Sanitary Problem 18
Drainage of Roads, Some Specific Suggestions on 173
Drainage Procedure in Iowa, Land, by G. D. Hart.....187
Drainage, Water and Sewerage Facilities at New Orleans, La., Unique Features of Unified Operation of, by George G. Earl 121
Dry Feeding of Chemicals Used in Water Purification, by F. B. Leopold.134
Dual System of Water Supply at Vinton, Iowa, How Obtained, by J. H. Dunlap 232

Electrically Driven Pumps for Small Water Works, by D. D. Ewing..... 68
Engineer in Politics—How Far Will the A. A. E. go in Politics? by W. A. Stinchcomb 214
Engineer, Should He Enter Politics? E.198
Engineers, Better Days Coming for, E..119
Engineers, if for Railroad, Why Not for Municipal and County? E..... 78
Engineers in Public Service, Three City Engineers Discuss Movement Calculated to Improve the Employment Condition of, ...216
Engineers' License Law, A Well-Considered, E..... 77
Engineer-Manager, The County Highway, by E. E. Sours.....101
Engineers, Municipal, Improving the Status of 179
Engineers, Public, to Promote Interest of, E. 159
Engineers, Testing Attitude of Political Candidates Toward, E..... 78
Engineering, One of the Things that Hurt, E. 160
Engineering Profession, Obtaining Proper Recognition of, by W. W. K. Sparrow 152
Engineering Problem, County, A Modern, E. 120
Engineering Society Success, a Remarkable, E. 1
Excavator With Side Wheel, New Model P. & H. 142
Explosives, Using in Removing Old Walls 226

Federal Aid Road Law; Experience to Date and Suggestions for Better Cooperation, by Logan Waller Page... 20

Federal Aid Road Act, All States Co-operate in 9
Filters, Ransome Drifting Sand, Performance at Toronto, Ontario..... 15
Freight Rates on Construction Materials Should be Decreased, Not Increased, E. 35

Garbage Disposal by Feeding, Baltimore Adopts, by Walter E. Lee..... 96
Good Roads, Walt Mason on..... 14
Grade Crossings, Railway Use of Precast Concrete Slabs 34
Grade Crossings, Railroad, Engineering Treatment of, by Rodman Wiley....191
Granite Block Pavements, Modern, Design and Construction of, with Special Reference to Manhattan Practice, by C. M. Pinckney.....199
Granite Block Pavements, Suggestions on the Proper Construction of, by A. T. Rhodes 106
Granite Paving Blocks Re-dressed, How Albany, N. Y., Saved $360,000 in Using, by F. R. Lanagan.....210
"Grouting Evil," Rigid Paving Inspection Needed to Cure, by Harlan H. Edwards 101

Hard Surface Roads Successfully Employed in New Hampshire, Two Types of, by F. E. Everett..... 80
Highways and Railways for the Defense of Our Nation 164
Highway Bill, National, Make a Law, E.197
Highways, Brick, of Ashtabula County, Ohio, by Ray N. Case..... 53
Highway Bridges, Recommended Procedure in the Painting and Maintenance of, by Chas. E. Snead.....171
Highway Construction, Day Labor, Force Account Work and Bonuses on, by Charles M. Upham..... 31
Highway Engineer - Manager, County, by E. E. Sours.....101
Highway Engineers, State, Twenty-five Report Their Plans for 1919..... 46
Highway Field, Opportunities in, E.... 1
Highway from Rockwood to Monroe, Michigan, Concrete, Design and Construction of, by L. C. Smith.....163
Highways, Heavy Traffic, Considerations Affecting Design of, in Ontario, by W. A. McLean.....157
Highways in Connecticut, State, City Pavements for, by Charles J. Bennett. 62
Highways, New York State, Snow Removal from, by Edwin Duffey..... 23
Highways, Permanent, Newspaper in Strong Plea for.....114
Highways, Relation of to Motor Transport Efficiency, by A. H. Blanchard..190
Highway Requirements for Twentieth Cenutry Transportation, with Special Reference to New Jersey Practice....208
Highways Under Heavy Motor Truck Traffic, New Jersey, Performance, by W. G. Thompson 28
Highway Work in Kansas, Some Features of, by M. W. Watson..... 86
Highway Work, Methods of Contracting for During the Reconstruction Period, by John H. Gordon.....110
Hydro-Electric Plants, Municipal, Small, Opportunities for and Dtata on, by W. G. Fargo 168

Illinois, $60,000,000 Good Roads Bond Issue, Campaign for, How Conducted, by S. E. Bradt 3
Irrigation, Some Financial, Agricultural and Engineering Aspects of, by Charles Kirby Fox 30
Iron Removal Plant for Laundry Water at State School, Sparta, Wis., Design and Performance of, by W. G. Kirchoffer 88

Labor-Saving Machinery, Use of, Versus Importation of Asiatic Labor, E. 2
Labor Situation, An Engineers' Thoughts on, by H. W. Skidmore.....150
Land Drainage Procedure in Iowa, by G. D. Hart 187
License Law, Engineers', Well-Considered, E. 77
Loader, Self-Feeding 72

Macadam, Reconstruction of Worn-Out On State Road in Rhode Island, by L. W. Patterson 81
Macadam Roads of Maryland, Building New Concrete Shoulders to Preserve, by John N. Mackall 79
Macadam Streets in Madison, Wis., Old, Methods Employed in Resurfacing, by George Sullivan 91
Machinery, Labor-Saving, Use of Versus Importation of Asiatic Labor, E.. 2
Maintenance of Public Utility Plants, by Robert J. Thomas..... 14
Maintenance, Road, by the Patrol Method in Maine, by Paul D. Sargent.117
Materials of Construction, Why Tested Prior to Use, by E. Mavant.....184
Mechanical Devices on Road Construction, Utilizing More, by Frank F. Rogers 18
Meter Holding Yoke, McNutt.....117
Military Roads as Constructed and Projected by the Construction Division, War Department, U. S. A., in 1918, by Daniel B. Goodsell.....140
Monolithic Brick Road, South of Seneca, Ill., Design and Construction of, by A. H. Hunter.....161
Monolithic Type of Brick Paving, Latest Seattle Specifications for, by W. H. Tiedeman 13
Motor Freight Transportation Aids Road Improvements 118
Motor Transport Efficiency, Relation of Highways to, by A. H. Blanchard...190
Motor Truck, New Methods of Handling Brick with Bodies Fitting Any..... 33
Motor Truck Traffic, Heavy, Performance of New Jersey Highways Under, by W. G. Thompson 28
Municipal and County Engineers? If for Railroad Engineers, Why Not for, E. 78
Municipal Construction Work by Day Labor in Flint, Mich., Performing, by Ezra C. Shoecraft 66
Municipal Engineers, Improving the Status of 179
Municipal Hydro-Electric Plants, Small, Opportunities for and Data on, by W. G. Fargo 168

"n" in Sewer Design, Selection of the Value of the Factor, by Paul E. Green 52
New Orleans, At, E.....120
Newspapers and the Business Press, E..160
Organization, Convinced of the Necessity for, E 198

Pavements and Surfaces Bituminous, Efficiency of Under Motor Truck Traffic, by Prevost Hubbard..... 98
Pavements, City, for State Highways in Connecticut, by Charles J. Bennett 62
Pavement Construction, Make Good on to Avoid Necessity of Making Excuses for Failure, by F. A. Churchill. 72
Pavement Failure Caused by Poor Brick, by C. C. Wiley.....179
Pavements, Granite Block, Modern, Design and Construction of, with Special Reference to Manhattan Practice, by C. M. Pinckney 199
Pavements, Granite Block, Suggestions on Proper Construction of, by A. T. Rhodes 106
Pavements in Chicago, Recent Developments in Design and Construction of, by H. J. Fixmer 92
Pavement, Machine for Removing and Loading as Operated by the United Railroad of San Francisco, by L. M. Edholm 118
Pavement, New, Pennsylvania Highway Commissioner Will Not Tolerate Opening of 188
Pavement, Open Joint, Wood Block, Procedure in Constructing at Toledo, O., by Raymond Pierce 174
Pavements, Preventing the Opening of New 102
Paving and High Prices..... 84
Paving, Brick, Monolithic Type, Latest Seattle Specifications for, by W. H. Tiedeman 13
Paving Inspection, Rigid, Needed to Cure the "Poor Grouting" Evil, by Harlan H. Edwards 101
Pipe Lines, Subsurface, Location of to Conserve Street Pavements.....225
Pitometer Survey and Constant Inspection Reduce Water Consumption at Buffalo, N. Y. 236
Politics and Prices, Local, E..... 77
Portable Conveyor for Handling Loose Bulk Materials, New Type of.....186
Power Hoist, Austin 74
Price Conspiracy, The, E 197
Prices and Local Politics, E..... 77
Prices, High, Paving and..... 84
Prices, High, Paving and..... 84
Prices, High, Is There a Propaganda for? E. 160
Prices, Present Level of, with Special Reference to Road-Making Materials, by S. M. Williams.....130
Prices, The Other Man's, E.....120
Public Engineers, to Promote Interests of, E. 159
Public Works Activity in All Parts of the Country, City and County Engineers' Report 154
Public Works and Construction Development, Division of, U. S. Department of Labor Creates 100
"Public Works or Public Charity?" E.. 35
Public Works Plans, More City Engineers Tell of.....112
Pumps for Small Water Works, Electrically Driven, Economic Value of, by D. D. Ewing 68

Ransome Drifting Sand Filters at Toronto, Performance of..... 15
Rate Adjustment, Valuations and Some of the Problems Incident Thereto, by C. M. Garland 74
Reclamation of Swamp Lands in Dane County, Wisconsin, by W. G. Kirchoffer 65
Reservoir of the St. Paul, Minnesota, Water Works, High Service, by W. N. Jones 165
Road and Street Surfaces, Importance of Adequate Drainage and Foundations for, by Clifford Richardson 146
Road Building Experience in Florida, Lessons Taught by, by G. Robert Ramsey 73
Roads, Concrete, Machine Finishing of, by E. G. Carr 132
Road Construction, Concrete, Road Contractor Successfully Employs Portable Charging Bins to Eliminate Dumping and Wheeling on Subgrade in, by George A. Burley 11
Road Construction in 1919, E..... 77
Road Construction, Utilizing More Mechanical Devices on, by Frank Rogers 18
Road Contractors in South Dakota, Shortage of 191
Road Contractor Successfully Employs Portable Charging Bins to Eliminate Dumping and Wheeling on Subgrade in Concrete Road Construction, by George A. Burley..... 11
Roads, Good, Why Returning Yanks Will Boost 84
Road Improvements, How Motor Freight Transportation Aids 118
Road Machinery, Consideration Affecting Choice of, by A. H. Blanchard....211
Road in Baraga County, Michigan, Design and Construction Features of, by G. C. Dillman 115
Roads, Macadam, Maryland, Building New Concrete Shoulders to Preserve, by John N. Mackall 79
Road Maintenance by the Patrol Method in Maine, by Paul D. Sargent.....117
Roads, Military, as Constructed and Projected by the Construction Division, War Department, U. S. A., in 1918, by Daniel B. Goodsell.....140
Roads, New, Precautions to Observe in Locating 92
Road Plans for 1919. Five More States Report 111
Roads Rational Design of, E..... 1
Roads, Specific Suggestions on Drainage of 173
Road Surfacing in Nebraska, Sand Clay, Experience with, by George E. Johnson 9
Road, The, Sell First, E..... 2
Roads, Two Types of Hard Surface Successfully Employed in New Hampshire, by F. E. Evcrett..... 80
Road, Worn Out Macadam, Reconstruction of in Rhode Island, by L. W. Patterson 81

Salaries of Railroad Professional Engineering Positions, Principles and Procedure in Classification and Standardization of, by J. L. Jacobs.....101
Sand Clay Road Surfacing in Nebraska, Experience with, by George E. Johnson 9
Sanitary Carts and Wagons.....168
Sanitation in Emergency Shipyards, by W. L. Stevenson 70
Sewer Design, Selection of the Value of the Factor "n", by Paul E. Green. 52
Sewer Design, Storm, Some Broader Aspects of Rain Intensities in Relation to, by Robert E. Horton.....218
Sewage Disposal Plant at Industrial Housing Development of the Alan Wood, Iron and Steel Co., at Swedeland, Pa., Design Features of, by George L. Robinson 135
Sewage Disposal Problem in Chicago, by C. D. Hill 180
Sewage Disposal Works in Reconstruction Period, by Harrison P. Eddy.... 60
Sewers in San Francisco, California, Equipment and Methods Employed in Building, by H. W. Shimer.....136
Sewer, Rideau River Intercepting, Ottawa, Canada, Design and Construction Features of, by L. McLaren Hunter 63
Sewerage Problems, Some Unusual and How they were Solved at Ocean Beach, N. Y., by A. J. Provost, Jr.....203
Sewerage, Water and Drainage Facilities at New Orleans, La., Unique Features of Unified Operation of, by George G. Earl 121
Shipyards, Emergency, Sanitation in, by W. L. Stevenson 70
Side Wheel Excavator, New Model P. & H. 142
Snow Removal from New York State Highways, by Edwin Duffey..... 23
Spillway for Flood Relief of the Big Sioux River, Sioux Falls, South Dakota, by Francis C. Shenehon.....143
State Highway Engineers, Twenty-five, Report Their Plans for 1919..... 46
Steam Shovels, A New Line of..... 62
Steam Shovel Practice, Modern, Review of With Recommended Procedure, by L. M. Edwards.....176
Steel Parts, Pressed, the Manufacture of 34
Sterilization of Water and Sewage....134
Street Cleaning in Rochester, New York, Recommended Procedure in, by J. W. Routh and J. T. Child..... 90
Swamp Lands in Dane County, Wisconsin, Reclamation of, by W. G. Kirchoffer 65

Tamping Cheaply with Home-Made Compressor Outfit 158
Testing Materials of Construction Prior to Their Use, by E. Mavant.....184
Trucks, War, Will Not Drug Market, E.120

Utility Plants, Public, Maintenance of, by Robert J. Thomas..... 14
Utility Plants, Public, Some Conditions Observed in, by Representative of the U. S. Fuel Administration, by Charles Brossman 94

Valuations, Rate Adjustment, and Some of the Problems Incident Thereto, by C. M. Garland 74

Water and Electric Utilities, Advantages of Combined Operation and Selling Current for Private Use at Springfield, Ill., by W. J. Spaulding.....229
Water Consumption, Reduction of at Buffalo, N. Y., by Pitometer Survey and Constant Inspection, by G. C. Andrews 236
Water Filter Plant, Design and Operation, Increasing the Efficiency of, Need of Certain Investigations for, by James W. Armstrong 5
Water Filters, Minneapolis, New, Design of Influenced by Experience Gained from Operation of Original Filters, by Lewis I. Birdsall 230
Water Main Under Full Pressure, 12-in., Methods Employed in Lowering..... 16
Water Pipe Line Trench, Loosening Hard Soil in Without Picking.....242
Water Mains in Alleys, Laying, by C. R. Henderson 240
Water Purification, Dry Feeding of Chemicals Used in, by F. B. Leopold..134
Water Purification Practice, Present-Day, Features of, by Milton F. Stein. 57
Water Service Line, Private Fire Protection, Proper Relations Governing, by Dow R. Gwinn.....193
Water, Sewerage and Drainage Facilities at New Orleans, La., Unique Features of Unified Operation of, by George G. Earl.....121
Water Supplies, Public, Methods of Removing Crenothrix from, by W. F. Monfort 182
Water Supply, Chicago's Chlorination of, by John Ericson 6
Water Supply, Dual System, How Obtained at Vinton, Iowa, by J. H. Dunlap 232
Water Supply of London, England, Notes on Chlorine Treatment of..... 28
Water Supply, Unsafe, Taking a Chance Proves Costly 15
Water Works, Advantages of State Supervision of, by Frederic Bass.....243
Water Works Conservancy, by Arthur A. Reimer 24
Water Works, Operation and Maintenance of, Effect of War Conditions on 16
Water Works Plant, How the City of Quincy, Illinois, Purchased a $1,000,000 with $380,000, by W. R. Gelston. 84
Water Works Reservoir High Service, St. Paul, Minnesota, by W. N. Jones.165
Water Works, Small, Economic Value of Electrically Driven Pumps for, by D. D. Ewing 68
Water System of the Dayton, Ohio, Water Works, Features of, by H. C. Wight..233
Wire-Cut Lug Brick Patents, Dunn, Sustained 67
Wood Block Paving, Methods Employed in Minneapolis in Constructing Smooth Surfaced Concrete Base, by Ellis R. Dutton 51
Wood Block Pavement at Toledo, Ohio, Open Joint, Procedure in Construeting, by Raymond Pierce 174
Wood Block Pavements, Modern, Suggestions on Design and Construction of, by E. A. Fisher.....129

EDITORIALS

Rational Design of Roads

The development of motor truck traffic on the highways will force the rational design of roads, as engineering structures, to withstand this character of traffic. Road design has been almost purely empirical. Roads have been proportioned with a knowledge of the performance of existing roads, just as masonry arches were once built by similar engineering processes, before the principles of statics and dynamics were at all understood.

In the last year or two highway engineers have been called upon to design roads to bear unknown loads, moving at unknown speeds in vehicles of unknown width and height. This, of course, is an indeterminate problem, and could be solved only by conjecture, without regard to economy and dependability.

The regulation of the weight, speed, height and width of motor trucks and trailers, which is progressing, will set the conditions a road must meet with sufficient precision to enable the engineer to plan intelligently. Highway engineering will become more exact henceforth and roads will be designed rationally rather than empirically, although the assumptions that must be made before the theories of mechanics can be applied will leave much uncertainty in the solution of problems of this class. Meanwhile the old engineering maxim will continue to hold good that "It is better to be safe than sorry."

A Remarkable Engineering Society Success

About four years ago a group of young Chicago engineers organized a new engineering society. It was undoubtedly an audacious thing to start a new engineering society in the year 1915. Only young men would have had the heart for such an enterprise. At that time the regulation rejoinder to every suggestion that a new engineering society be formed was, "Heaven forbid!" Add to the opposition against all new engineering societies, existing then as now, the fact that these audacious young men dreamed of improving the engineer's financial status, and one can perhaps appreciate the discouragements heaped on their heads. Yet despite all ridicule, hostile criticism, impugning of motives, and all the rest of it, the young men made good, and their new society, called the American Association of Engineers, has made good, although its work is not yet finished.

The editor finds peculiar satisfaction in hailing the success of this organization, for he did what he could to discourage its founders. His aid was sought at the outset, but he was weary from his efforts to arouse engineers to an enlightened self-interest, and advised the young men not to attempt a labor which had so many times proved abortive. Fortunately they did not take his advice.

This organization, at first referred to by the bourbon element in the profession as "a group of disgruntled minor assistants," has now advanced to such standing that it has for its president the president of a great railroad. Among its officers and directors are men of national reputations as engineers. As secretary it now has the man who, as secretary of the Cleveland Engineering Society, did the first and most conspicuously successful engineering society publicity work in this country.

The association is incorporated, not for its own pecuniary profit, but for the profit of its members and of the most obscure engineer in America. It is worthy of all co-operation and all support.

Make Costs Known in Self-Defense

Speaking at the recent convention of the Highway Industries Association, Governor Lowden, of Illinois, stated that prices will govern to some extent the amount of road construction to be placed under contract in this state during his administration. He intimated plainly that he regarded prices as artificially high, and appeared to be of the opinion that contractors and material men were asking too great profits.

Now, there is no question of the Governor's sincerity and there is no question of his desire to see a statewide system of public roads built in Illinois. His energetic leadership and unqualified indorsement of the great road-building program in this state made the success of that program certain. His efforts on behalf of good roads are fully appreciated. But it is evident to the initiated that the Governor is under a misapprehension as to the profits made by road builders. Another year or two as profitable as 1918 and the entire highway industry would be bankrupt.

It was suggested, therefore, at the convention mentioned, that costs be made known at least in sufficient detail to convince the public that no undue profit is being made, or is likely to be made, by any firm or individual engaged, or in any way concerned, in road building.

Opportunities in the Highway Field.

The highway field offers attractive opportunities to engineers. Recently the highway commissioner of one of the leading states expressed the opinion that the present shortage of highway engineers will become more marked in the years coming. Highway work in prospect is vastly more extensive than anything in this line the country has experienced. Not only will state highway organizations grow, but county highway organizations will also grow greatly.

The road building so far carried on has served to acquaint the public, if but imperfectly, with the worth of the services of the highway engineer. Public opinion now demands engineering in connection with highway construction where even a test road has been built.

Young men entering the engineering field will now come in over the highway instead of the railroad. For a generation young engineers have taken the easy way by getting a job on the railroad. Some advanced, many stood about where they started, and a great many went back to the farm. Highway engineering can never be less appreciated than railroad engineering has been, so the engineer who enters a highway

organization will surely fare as well as the railroad engineer, if he does not fare as far. He will see more of his family if less of the world.

Sell the Road First

There is room in the great highway field for all the workers now in that field and for all competent persons who may enter it in the near future. This is admitted by leading representatives of every interest concerned. More good highway engineers are needed; many more good highway contractors will be needed soon, and there is room on American highways for every pound of good road-making material that can be produced in the next decade.

While the leaders of thought among the so-called "material" men fully recognize that there is room for all, this does not mean that there is to be less sharp competition than heretofore in the sale of road-building materials. Lieutenants may, in their natural zeal to get orders, argue the merits of a material to the exclusion of the merits of the project for which the material is intended. This may be fatal to the project, and therefore harmful to the public as well as to the entire highway industry. For this reason a prominent worker in the Highway Industries Association recently proposed as a slogan for all material men: "Sell the road first." This thought should be emphasized in every organization until it is appreciated.

Since there is room for all, competition can and should be fair. The public is undoubtedly in a road-building mood and will remain of that persuasion until the roads desired are secured, or until faulty construction or unwise promotional methods temporarily discredit the entire road-making program of the country.

The highway industries are soon to have their golden opportunity, and they must make good. Those who serve best will surely profit most.

Use of Labor-Saving Machinery Versus Importation of Asiatic Labor

Observers, generally, agree that the labor situation in this country is likely to pass rapidly from one extreme to the other. In the first period there will be an oversupply of labor and in the second period there will be a shortage of labor. The first period will be of short duration in comparison with the second.

We have entered upon the first period, brought about by the demobilization of soldiers, sailors and war industries laborers who have not yet been absorbed into the normal industrial pursuits. It is now highly desirable to launch great programs of public works construction, not only to provide improvements postponed because of the war, but to provide useful and profitable employment for labor during the months of readjustment from a war to a peace footing.

Public works and other normal enterprises once fully released will rapidly gain momentum, and it is believed by many close students of economic conditions that the first period of oversupply of labor will be followed soon by a period of labor shortage. Many hold that well over a million European laborers who have sought asylum in America during the war will return to Europe as soon as the menace, to them, of war service in European armies has been, for the time, definitely removed. Labor conditions in Europe will surely be better after than they were before the war, thus making the European laborer better contented with his surroundings and correspondingly decreasing the lure to him of the American dollar. Thus, with the demand for labor increasing, in the second period, and the supply of labor progressively decreasing, an acute labor shortage may come in 1920 or 1921.

How shall this labor shortage be met? The reconstruction of Europe, physically and industrially, will prevent the usual additions to American labor supply through immigration from Europe. "The belief is rapidly growing," says one observer in the construction industry, "that the solution is the importation of Asiatic labor."

On the high ground of national welfare and of Americanization the importation of Asiatic labor should be opposed. This country is already too much of "a polyglot boarding house," to use the phrase of the late Theodore Roosevelt. If coolies from the Orient are admitted to this country to solve a labor shortage problem they will not only further complicate social affairs, but will inevitably lead to international complications of the first magnitude.

Relations between the United States and one Asiatic country have been strained for years because we not only do not want any more of the subjects of that nation to settle within our borders, but would be glad to have many of those now here return to their native land. Only the good offices of a mutual friend among the nations have prevented an open clash over the immigration question between the United States and the Asiatic nation to which reference has been made. Let it be clearly understood that it will be vastly easier to admit Asiatic labor when we may want it than it will be to get rid of it when we no longer want it. Let it be recalled that the importation of African labor once solved a labor shortage in this country, but the solution of one problem left a greater problem which is with us still, in spite of all efforts to solve it from generation to generation and despite the expenditure of much blood and treasure in the effort. Let us be intelligent enough not to duplicate that mistake, and let us not be so foolish as to suppose that the consequences of such a mistake can be avoided merely by switching colors.

What, then, is the remedy? The remedy, in the construction field at least, is the more general employment of labor-saving machinery. In this field labor-saving machinery has established its worth wherever it has been given a fair trial. Once properly recognized, it is capable of great development which will progressively improve industrial conditions and progressively lower production costs.

The attitude of engineers and contractors toward labor-saving machinery, generally speaking, is not what it should be. The present attitude is too much of a "show me" attitude. There should be more willingness, more eagerness to be shown. Instead of being skeptical and coldly critical of the manufacturer's efforts (backed by the manufacturer's money), the contractor and engineer should adopt a policy of helpfulness and co-operation with the manufacturer. They should help him with advice and suggestions and should give him the benefit of every reasonable doubt. It should be realized that in the production of labor-saving machinery the manufacturer is performing a public service. It is true he aims to profit from this service. He is not always successful; when he does make a fair return on his invested capital, he is clearly entitled to it.

How the Successful Campaign For the $60,000,000 Good Roads Bond Issue Was Conducted in Illinois

By S. E. Bradt, State Superintendent of Highways, Springfield, Illinois

It had been generally recognized by the friends of good roads throughout the state of Illinois that no great progress could be made in the way of road improvement without making available a fairly large sum of money through a bond issue. The opportune time for launching such a campaign did not present itself until the latter part of 1916. At that time there was developed by the State Highway Commission a plan involving a state road bond issue of fifty millions of dollars.

The unique feature of the plan was that the bonds were to be paid one-half from motor license fees and one-half from general taxation. In order to insure the providing of ample funds through motor license fees, it was proposed to increase the fees 50% above the then existing rates. Our first move was to present this proposition of increase in motor fees to the officials of the motor organizations of the state. The matter was carefully gone into by them and the plan approved.

In Charge of Illinois Highway Improvement Association

There had been formed in 1911 for the purpose of advancing highway legislation in Illinois, the Illinois Highway Improvement Association of which Mr. Wm. G. Edens of the Central Trust Company of Chicago was president. This organization had been influential in passing the revised highway law of 1913. Naturally, therefore, we turned to Mr. Edens and the Illinois Highway Improvement Association with this advanced plan for the improvement of the highways of the state. Mr. Edens immediately called a meeting of the directors for the purpose of discussing the plan. It met with their unanimous approval.

Plan Submitted to Governor-Elect Lowden

This was in November, 1916, shortly after the election of Frank O. Lowden to the governorship of the state. Realizing that his co-operation was essential, the plan was placed before him. He stated, after going into the matter carefully, that while he was not fully prepared to give his approval to the measure he realized that if any great amount of work was to be accomplished it could be done only through a large bond issue and that he thought it proper to begin a campaign of information.

Following the meeting with Governor-elect Lowden, the Illinois Highway Improvement Association called a state-wide meeting at Danville. At this meeting some 250 prominent farmers and business men representing all parts of the state came together. They devoted an evening and an entire day to the consideration of the question in all its phases and finally gave it their unanimous endorsement, after raising the amount of the proposed bond issue to sixty million dollars.

Outlining the System

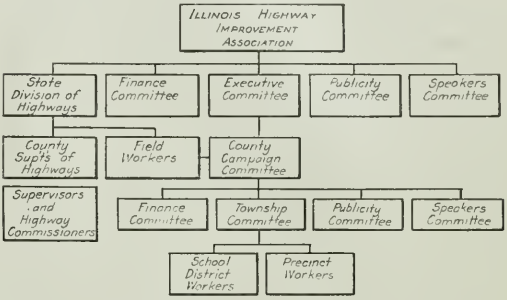
Prior to the meeting of the directors of the Illinois Highway Improvement Association, the State Highway Department had outlined a state-wide system of highways comprising about 4,000 miles connecting practically all of the cities and villages of 2,000 and greater population in the state. This system reached directly about 66% of the population and extended into every county of the state. It was adopted by the Danville convention and became the basis of the bill introduced into the legislature.

Paid Entirely From Motor License Fees

In January, 1917, the Fiftieth General Assembly convened. Before preparing the bill for the consideration of the legislature another conference was held with Governor Lowden, at which representatives of the various motor organizations of the state were present. At this meeting Governor Lowden stated that the demands on the revenues of the State of Illinois were growing so rapidly and the taxation was already so heavy that he would not favor any plan which would involve an additional tax upon farms, homes or other property, but if the motorists of the state were willing to assume the payment of the entire proposed bond issue and interest instead of one-half of it, as previously agreed to, he would favor it. He further stated that in order to do this it would be necessary to increase the motor fees 100 instead of 50%. After some consideration this was agreed to by the representatives of the automobile organizations and the bill was prepared along that line.

Legislative Career

The presentation of the bill to the legislature was the next step. The members of the General Assembly offered practically no opposition to the proposition of issuing bonds in the manner already agreed upon; but there were many demands for changes in and additions to the system. After a number of hearings before the House and Senate committees, and its final reference to a conference committee, the bill was approved in June, 1917, involving in its final form a system of



ORGANIZATION CHART OF WORKERS IN THE ILLINOIS $60,000,000 ROAD BOND ISSUE CAMPAIGN.

approximately 4,800 miles of the main highways of the state. In the meantime, the plan had been presented to many organizations. It had received the approval of the entire farm press of the state and also the approval of the Illinois Farmers Institute, one of our most influential farm organizations.

At the time the bill was introduced in the legislature, the United States was not involved in the European conflict, but before its final passage war had been declared.

Plan of Campaign

Following the passage of the bill, the Illinois Highway Improvement Association commenced the outline of its plan of campaign. The plan proposed met with practically no opposition wherever it was understood but the man who failed to have full information in regard to it was inclined to oppose this bond issue the same as other bond issues, fearing additional taxation. In this connection, attention is called to the fact that instead of requiring only a majority of the votes cast upon the proposition, the Constitution of Illinois required a majority of votes cast by men voting for members of the General Assembly, which meant practically a majority of all votes cast at the election. This feature, combined with the general opposition to bond issues which necessitate additional taxation, made necessary the carrying on of a vigorous campaign of information.

Wide Endorsement by State and Local Organizations

The war, however, had become the all-absorbing topic. People, with the exception of those particularly interested in road improvement, who needed no convincing, would not take the time to attend good roads meetings. It therefore became necessary to formulate a different campaign from that ordi-

narily carried on. Instead of the projected road meetings our attention was given to securing a place for our speakers on the programs of all public gatherings. At these meetings, the plan was presented briefly and an endorsement requested and usually unanimously given. Before the closing month of the campaign we were able to show the most formidable list of endorsements, both from organizations and from prominent persons, ever given to any one project presented to the people of the State of Illinois.

Forming of County and Precinct Organizations

In addition to the foregoing, which was of a general nature, it was deemed essential to carry on a local campaign in each community. For this purpose there was appointed a county campaign committee in each county. This committee consisted in the beginning of from three to five members who were permitted to make such additions to their committees as they saw fit. Great care was used in selecting these county committees so as to be sure to have people of standing in the community as well as those who were enthusiastic road advocates.

The county committees were requested to meet and elect a chairman, secretary, treasurer, and publicity manager and then proceed to organize the county by naming township chairmen and precinct and school district committeemen as well as workers at the polls on election day. During the last few months of the campaign, field men were sent out to visit the various county campaign committees and assist them where necessary in completing their organizations and in carrying on the campaign. Where it was found necessary, these field men went to the counties several times before election day. The work done by these county organizations in a hand to hand manner is undoubtedly responsible for a large measure of the success of the bond issue.

Publicity Through Literature

Another feature of the campaign which will be of interest is the manner of publicity. The Illinois Highway Improvement Association furnished to the county committees the necessary literature consisting of maps, booklets, circulars, folders, etc. These included a text book, covering the entire plan in detail to be used by those who wished to prepare themselves to talk both in public and privately for the bond issue. A state map 15x28 ins., showing the bond issue system and giving essential details of the plan, was distributed; also three different circulars written by well known farmers; three labor circulars prepared by well known labor leaders; a circular covering the financial phase of the situation: and during the last 30 days of the campaign a folder appealing to automobilists was distributed through all of the filling stations of the state. A small leaflet for use by manufacturers in the employes pay envelopes was another feature; and finally, a sample ballot for distribution on election day and badges to be worn by those favoring the proposition. The greater part of these circulars, folders, and leaflets were brief and yet contained the main facts regarding the proposition. Not less than 6,000,000 pieces of literature were distributed by the Illinois Highway Improvement Association mainly through the county organizations.

Newspaper Publicity

Another thing that should be given special mention is the co-operation of the newspapers of the state in this campaign. All of the papers, including the metropolitan dailies, the country daily and weekly papers, the farm and trade papers, gave of their space freely. During the last six weeks of the campaign two full page sheets of publicity matter were sent out by the Illinois Highway Improvement Association. This was furnished in the form of boiler plate to those papers so desiring it, while to others the copy was given and set up on their own linotype machine. It is estimated that approximately 25,000 columns of printed matter pertaining to the bond issue were donated by the newspapers of the state.

Special Motion Picture Film

Another interesting feature of the campaign was a two-reel film, prepared and circulated by the Illinois Highway Improvement Association. This was entitled "Through Illinois Over Unchanged Roads in a World of Change," and was furnished without expense to moving picture houses. It was used generally over the state until it became necessary, because of the influenza epidemic, to close all moving picture houses. Wherever it was shown it brought out unusually favorable comment and it is to be regretted that we were unable to use it to the end of the campaign so as to get the full benefit of the ten sets of films which were circulated.

Closing the Campaign

During the last six weeks of the campaign, we were handicapped first by the launching of the Fourth Liberty Loan campaign which closed about three weeks before election, and following this, the influenza epidemic. Practically all county committees had arranged for township and school house meetings either in the interest of the bond issue alone or in connection with political and other gatherings. The order issued by the State Board of Health prohibiting all public gatherings forced us to make a sudden change in the campaign from public meetings to newspaper and poster advertising. The Illinois Highway Improvement Association immediately printed and forwarded to the county campaign committees for circulation 50,000 half-sheet posters. In addition, the county committees were urged to use, especially in the larger centers of population, half page and page paid advertisements in their daily papers. Also a thorough organization of non-partisan poll workers had been effected by the county campaign committees generally throughout each county. These workers were at the polls with the sample ballots, wearing bond issue badges and urging the people to vote for the road bond issue. This was supplemented by both the republican and democratic poll workers who gave the proposition their hearty support. On the little ballot with the road bond issue was the proposition of submitting the question of the constitutional convention in which the women of the state were greatly interested. Because of this, many women workers were at the polling places supporting not only the constitutional convention proposition, but also the good roads bond issue.

Effect of the War on the Campaign

Shortly after the adjournment of the legislature much unfavorable comment was heard concerning the bond issue on the grounds that while we were engaged in this stupendous war we had no time to think of or discuss a good roads bond issue; that the entire matter should be postponed until some later date. Our governor with his usual foresight then came to the rescue by making a public statement to the effect that if the bond issue was approved by the people he would not issue the bonds or commence construction until the close of the war. In connection with this statement, he called attention to the fact that economists predicted a period of depression following the war in which we would probably find labor plentiful and work scarce. In view of this probability, he urged the people to approve the bond issue in order that the State of Illinois would be prepared to do its share in providing employment for the soldiers returning from the front and the civilians released from war industries. This statement immediately relieved the situation and proved to have a decided influence on the minds of the people in favor of the bond issue.

Its Financing

The financing of the campaign was done entirely through personal contributions. The Illinois Highway Improvement Association, through its finance committee, raised sufficient

funds to pay for all printed matter and the preparation of the public news sheets furnished to the press of the state; also to defray the general office expense which was considerable. The local campaign expenses, including the payment for local newspaper advertising, were provided by the county campaign committees.

What is Shown By the Returns

The total legislative vote cast at the election was 898,821; the vote for the proposition was 661,815, thus giving a majority of 212,404 votes on the constitutional basis. The votes against the proposition were 154,396, a majority of 507,419 or over four to one on the basis of those voting on the proposition itself. This vote is evidence of the excellent work done by every person interested in the campaign.

The harmonious and enthusiastic co-operation of the Illinois Highway Improvement Association, the State Division of Highways, the county campaign committees and their associates, with Governor Lowden, who was the real leader in every crisis, is shown by the results of the election. And the results of the election also show that the people of the entire state are sincere in their desire to "pull Illinois out of the mud."

Need of Certain Investigations for Increasing the Efficiency of Water Filter Plant Design and Operation

By James W. Armstrong, Filtration Engineer, Water Department, Baltimore, Md.

When a procedure becomes established in any profession, as good practice, it is generally based upon sound theory backed by experiment. But on account of the costliness and the time required for making experiments, the difficulty of securing necessary data or the fear of departing from established precedents, there have been incorporated into public works many important details that do not adequately perform the part for which they were designed.

Mixing Basins and Coagulating Basins

The art of purifying city water supplies is too new to expect that the last word has been said regarding any particular feature of the process. For instance, mixing basins and the coagulating basins are very important features of most filtration plants, about which there is still much to learn, and any information that would lead to a better understanding of their proper functioning should be of great service. Both engineers and operators have opinions varying greatly regarding their proper design. It is very difficult to draw correct conclusions by comparing data obtained at different plants by experiments on different kinds of water, treated in different ways. Unfortunately, there is very little data available for comparing the various methods of handling water that has had identical chemical treatment.

Most Efficient Mix with Least Loss of Head

In most plants there is only a limited head available for the purpose of mixing chemicals, and the problem in design is the one of getting the most efficient mixing with the least loss of head. The two most common methods of mixing chemicals with the water are by passing the water through longitudinal channels around the ends of baffles, or by passing it vertically up and down through narrow passages and over and under vertical baffles. As most plants have a wide range in the volume of water treated at different times, it makes difficult the problem of designing any system of baffles intended to take care of different rates of flow. The effect of changing the velocity can readily be seen, as at times of minimum flow a carrying velocity, in all probability, cannot be maintained, and sediment will be deposited; whereas, at times of maximum flow, sediment will be picked up and carried into the coagulating basin.

Time and Intensity of Agitating Water

In some plants the water is treated by passing it through very long and comparatively smooth channels; in others, the water is baffled by many turns, but the time period allowed is much less, while in still other plants the agitation is accomplished by mechanical means.

There is evidently some relation between the time element and the intensity of the agitation given to the water. For instance, what would be the effect on the treatment of water passed through a plant in three different ways, if a total head of 4 ft. was available for the coagulation of the water, first, by a series of long passages where velocities were slow and friction losses light; second, by passing through a well-baffled basin where velocities and friction losses were fairly high, and, third, an extreme case probably never tried, where the entire head should be consumed at a single drop? Probably neither extreme would give the best results; but the question is, at what point between the two could the correct answer be found?

Mechanical Agitation

It has been noted that water of a given turbidity, treated with the same amount of chemicals, does not always give an equally good floc. It is well known that water containing fine colloidal matter is much harder to treat than water of the same turbidity which contains a different kind of suspended matter. This fact seems to indicate that it might be well to have, in addition to the regular baffling system, a mechanical means of agitating water at times when it contains a particularly large amount of this colloidal matter.

Type of Baffle

It has also been noticed by laboratory experiment that a floc can be formed in water identically treated with chemicals, by stirring rapidly or by alternately applying and releasing pressure. But, as it is impossible to make laboratory experiments that would adequately represent the actual operating conditions in treating water, it is desirable to know from experiments on similar water whether or not there is any advantage due to the type of baffling used; that is, whether the over-and-under baffle, embodying the application and release of pressure as the water passes from the top to the bottom of the channels, adds anything to the efficiency of the treatment, as against that obtained in the round-the-end type.

Coagulation Basin Design

It is not always possible in designing a filtration plant to secure an adequate and properly designed coagulating basin, on account of the many factors entering into the design. Unfortunately, practical consideration such as topography, the cost of the plant and the general arrangement of structures, often prevent the securing of a proper basin. But even with ideal conditions prevailing, the question arises, how should the coagulating basin be designed to secure the greatest amount of precipitation and deliver water to the filters in the best possible condition?

The studies that have been made in the past by engineers to determine the laws governing sedimentation in still water, hold only in a general way for flowing water. Observations made with well-designed, submerged floats that expose practically nothing to the wind, in a coagulating basin of a type where water enters one-half, passes around a baffle extending about two-thirds of the way back, and leaves the basin on the same line as that at which it entered, showed very different movements at different times. Turbidity surveys of the basin, with readings taken at intervals of 10 ft. in both directions throughout the basin, have shown well-defined turbidity zones where the heavier turbidities coincide in a general way with the main path of the floats. Repeated observations made at different times and with floats at different depths have failed to reveal any information that would indicate ideal coagulation was being obtained.

Securing Ideal Coagulation

To secure ideal coagulation, water in its movement through a basin should show a uniform displacement, a gradual clearing, and should not pick up sediment that had once settled out. Different engineers have very different ideas as to the best method of accomplishing this result. Some believe that the water should move straight through the plant without any baffling. Others believe the method of passing water around a series of baffles to be the best; while still others hold that water should be admitted at the bottom, taken off at the top, and perhaps baffled this way several times before being drawn. There are others who hold that the water should be admitted from the top and drawn from the top, and that baffling should be inserted that would keep the movement of the water entirely at the surface.

Sedimentation Basins

There are some phenomena governing the action of sedimentation in basins not fully understood, as is shown by the following:

In a plant operating two basins, and under apparently identical conditions, it was noticed one day that one of the basins gave a markedly better water than the other. Upon making a slight alteration in the opening of the gates feeding the basin which was giving the better results, it was noted that on the following day the conditions had actually reversed. Careful consideration of these observations has led to the conclusion that the currents induced by the movement of the water through a basin, due to one cause or another, have much to do with its proper coagulation. It is believed that a more careful study of the whole question of the proper arrangement and baffling of settling basins would result in increased efficiency in designing filtration plants.

Chlorination of Chicago's Water Supply

By John Ericson, C. E., City Engineer of Chicago

Chicago has always been liberal in the quantity of water supplied her people and her varied industries. At the present time, notwithstanding continued efforts at conservation, necessitated by reason of unwarranted preventable leakage and waste, the amount of water supplied per capita and in total is greater than the amount supplied by any of the greater water works systems in the world.

There is an inexhaustible body of water close at hand, and the greater part of the city streets are less than 20 ft. above the surface of the lake. To the average non-technical mind no convincing reason has been recognized or accepted why the quantity of water supplied to the people should not be unlimited, and, therefore, the per capita, as well as the total quantity of water pumped at the city's pumping stations has steadily increased, the present daily per capita pumpage being about 260 gals. and the average daily pumpage from 638 to 740 million gallons, varying with the season and weather conditions.

Sanitary Efforts

Efforts have continually been made by the municipality to safeguard the purity of the water supply, by locating intake miles from shore and by the construction of intercepting sewers and the sanitary district channel, by which the flow of the sewage laden Chicago river has been reversed, thus diverting the greatest part of the city's sewage away from Lake Michigan, the source of our water supply. Some portions just north and also the southern part of the city still discharge sewage laden water into the lake. Work is now in progress, however, under the direction of the Sanitary District of Chicago, which will also soon divert the sewage of these sections: on the north by the construction of intercepting sewers and a pumping station in the city of Evanston, which will divert to the North Branch channel, and on the south by the construction of the Calumet Sag channel with necessary auxiliaries which will carry into the main drainage channel the polluted waters from these districts.

The disposal of dredgings from the Chicago river into the lake, as well as the navigation of large passenger steamers, will, however, be more or less a source of pollution as long as it exists.

The beaches along the shores of Lake Michigan are being used to a largely increasing extent for bathing purposes in the summer months. These and other reasons made apparent the necessity for further efforts towards the conserving of the purity of the water supply.

Chlorination

Filtration of the Chicago water supply being a gigantic problem, treatment of the water by the hypochlorite of lime method was tried experimentally early in 1912 at the Edward F. Dunne intake crib, supplying the Roseland pumping station. In July, 1912, this treatment was extended to the 68th street crib, supplying the large pumping station located at 68th street and Oglesby avenue. In August, 1913, a similar experimental plant was also placed in operation at the Lake View intake crib.

Many difficulties were encountered with these installations. During cold weather the freezing of the solutions in tanks and pipes, the blocking up of the distribution pipes by anchor ice, and difficulty in the delivery of hypochlorite to the cribs caused periodical shut-downs of the plants. There were also many complaints by consumers on account of a disagreeable taste to the water.

Liquid Chlorine

As liquid anhydrous chlorine had been used with apparent success in various places and apparatus for its use for water sterilization purposes had been developed to a point where the city was justified in taking up the matter seriously, an installation for trial and experimentation was made.

Two sets of liquid chlorine apparatus, made up by using a modified acetylene gas reducing valve combination, purchased from a Chicago manufacturer, were temporarily installed and connected to the intake of the 68th street crib. The apparatus was installed for the purpose of making tests of the feeding and regulation of dry chlorine gas, to secure data on the effect of temperature on the flow of gas, to test the effect of the gas on feed pipes and fittings of various materials, and to secure other valuable information.

The machines were operated by the regular employes of the crib under the direction of the city engineer.

After this experimental work machines for the administration of liquid chlorine were installed in all of the city's pumping stations.

Dates of Placing Chlorinators in Service

The dates on which the machines were placed in service at the various stations are as follows.

Chicago Avenue—Sept. 6, 1915.
Twenty-second Street—Dec. 15, 1915 (for temporary service test and adjustment).
Twenty-second Street—Jan. 4, 1916 (permanent).
Sixty-eighth Street—Mar. 4, 1916 (temporary).
Sixty-eighth Street—July 1, 1916 (permanent).
Lake View—April 4, 1916.
Roseland—July 10, 1916.
Fourteenth Street—August 24, 1916.
Harrison Street—August 26, 1916.
Central Park Avenue—Sept. 27, 1916.
Springfield Avenue—Oct. 6, 1916.

The new equipment was comprised, with one or two exceptions, of the Electro Bleaching Gas Company's Model C, manually controlled apparatus, consisting essentially of manifolds to which the required number of cylinders may be connected, regulating and controlling valves, high and low pres-

sure indicating ganges, a meter to indicate the rate of flow of chlorine gas, and a so-called absorption tower into which the chlorine gas and a small stream of water are introduced in such a way that the water will absorb the chlorine gas and flow to the point of application of either the common suction well of several pumping engines or the suction pipe of an individual engine.

Installation of Apparatus

The installation of the chlorine controlling apparatus in the different stations has been varied to suit local conditions. In general, each installation was placed in a well sealed half

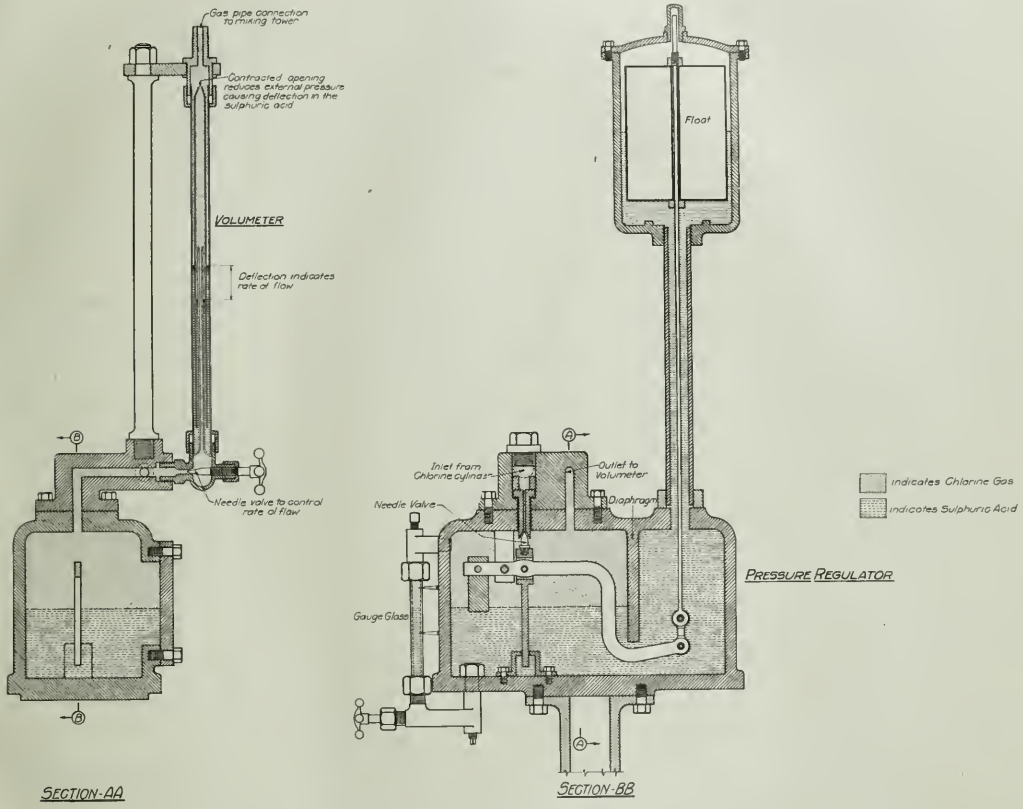


DIAGRAM INDICATING OPERATION OF MILLER AERISOSTAT.

glass wooden booth or enclosure provided with coil or radiator and an indicating thermometer in order to maintain proper conditions of temperature and dryness.

An electric motor-driven ventilating fan with intake connected by copper suction pipe, with its opening near the floor of the booth, was installed in each place to remove the chlorine gas which might escape. The motor control switch was placed outside the booth to permit ventilation before the booth is entered.

The maintenance of this apparatus, with its many delicate devices, in proper service operation, has been a difficult matter, notwithstanding all the precautions which have been taken to prevent leaks, breakdowns, etc. The regular station employes had to be slowly trained in the handling and care of the apparatus. When a man had become somewhat familiar with its use, his call to war service or absence on vacations made substitutes necessary, and this more or less aggravated the situation.

Chlorine gas is a very difficult substance to handle. Material of parts which pass through all tests under air, steam or water frequently proves porous or imperfect when subjected to chlorine gas. The city has been fortunate in having its own shops and foundry, which has enabled it to keep the apparatus in continuous operation, which would have been practically impossible if we had been obliged to depend entirely upon the manufacturer for repair service.

The apparatus now in use in the older stations is unquestionably capable of considerable improvements, particularly along lines which will eliminate numerous delicate parts, joints and valves, and that will give a more dependable distribution of the amount of chlorine to be fed to the water.

Improvement to Apparatus at Mayfair Station

A step in this direction has been taken by the city in connection with the new Mayfair Pumping Station, located in the northwestern part of the city, and which was placed in service in August of this year.

This station contains five triple expansion pumping engines of the plunger type with a combined capacity of 110 million gals. per day. The ultimate capacity of the station will be about 152 million gals.

The water is supplied to these pumps through a tunnel with the intake three miles from shore. From the main shaft at the pumping station, which is located five miles west of the

lake shore, the water is distributed to the pumps through two branch tunnels connecting at a higher eelvation with the main shaft located in front of the station.

Thus all the water which is pumped at the Mayfair pumping station has to come up through this main shaft, and it was selected as the most suitable and effective point to apply the chlorination. The pipes conducting the chlorine solution into the water as it rises from the tunnel through the main shaft extend 55 ft. below the horizontal branch tunnels, thus giving the chlorine as much time as practicable to act on the water before it enters the pumps.

Essential Features of Installation

The chlorine apparatus of the Mayfair station consists of two complete and independent sets, so that in case of a breakdown of one of them the other may be thrown into use very quickly.

Each unit consists of a group of a battery of nine (9) chlorine cylinders connected with suitable tubing to the manifold receiver where the pressures from the various chlorine cylinders are equalized. From this manifold receiver the gaseous chlorine passes into a so-called aerisostat, a chamber that regulates the quantity of chlorine required and wherein the pressure is reduced sufficiently just to drive the chlorine gas through the wrought iron piping into a room constructed over the main shaft and the floor of which is 7 ft. above low lake level.

In this room are situated two sets of two mixing towers providing for the reception of four ¾-in. chlorine pipes. These mixing towers are 7 ft. high and are filled with pumice stone; they are made of hard rubber and are 8 ins. in diameter. One of the chlorine pipes enters each mixing tower from the top and extends to within 6 ins. of the bottom. It is covered with a copper spraying cone into which during operation a stream of filtered water falls, which, by gravity, works down through the pumice stone in the mixing tower. The chlorine gas in rising in this same enclosure is absorbed by the water, thus forming the real chlorinating solution.

From the bottom of the mixing tower extends a hard rubber pipe 1 in. in diameter connected to a 1¼ in. inside diameter rubber hose through which the chlorine solution finds its way into the raw water at about an elevation of 90 ft. below low lake level or datum. This hose is protected by a 2 in. extra heavy galvanized iron pipe anchored to the walls of the shaft. This describes in a very brief and general way how the chlorine is administered to the raw water.

The regulating and pressure reducing part of the apparatus called the *acrisostat* differs in principle from the other installations. It is simple and compact, and from months of trial it promises greatly to reduce the cost of maintenance and to insure a more accurate distribution of the chlorine gas.

A detailed description of this apparatus cannot be given here, but the general principles on which it is designed are as follows:

The Acrisostat

The chlorine regulator or *Acrisostat* is essentially low pressure float-controlled chambers, based on the principle of a U-tube, as shown in the illustration, with legs of different areas proportioned to equalize the effect of the higher pressure of chlorine cylinders and the low pressure required for the delivery of the gas to the absorption tower or other point of delivery.

The main chamber of the regulator is divided into two parts or proportionate areas by a partition extending downwards to within a certain distance of the bottom. This chamber is nearly filled with pure sulphuric acid. Chlorine gas from the cylinders is admitted to a circular opening in the top of the chamber, the under side of which opening forms a seat for a vertical needle valve.

As soon as gas is admitted through this valve into the larger part of the chamber the pressure of the gas upon the sulphuric acid in the larger chamber forces the liquid up into the smaller one. A float in this chamber is connected to the vertical needle valve by levers and rods in such a manner that it controls the opening and closing of the valve, as the pressure of the gas causes the fluid to rise or lower in the smaller chamber. This regulation in the older apparatus is obtained by two or more frail reducing valves of the diaphragm type with counteracting springs. These required close watching and attention to keep them in operating condition.

The chlorine platforms and accessories are enclosed in partitions of steel and glass, isolating the installation from the pump room. An electrically operated exhaust fan ventilates the enclosure driving the exhaust air out through an opening in the roof of the gate shaft. A red pilot light indicates from a distance when the fan is operating. The ventilating conduit is a 6-in. diameter No. 16 gauge copper pipe. Provision for heating has been made so as to keep the temperature within the enclosure between 90 and 95 degrees Fahrenheit, and in the main gate shaft the temperature should not go below freezing point. The temperature is controlled by thermostats.

It is important that the amount of chlorine used be accurately determined, and as a check on the distributing apparatus two dial reading chlorine weight indicators are installed. The weighing platforms are inside the enclosure, but indicators are placed outside. The pointers are so arranged as to show directly the number of pounds of chlorine used. The recording gauges showing the pumpage of the water, as well as those showing the dosing by chlorine, give an accurate account of the proportion of chlorine used to the water pumped. It would, however, be far more desirable if a satisfactory means can be introduced which will automatically regulate the amount of gas used in a definite proportion to the pumpage. This seems feasible with a Venturi meter when used to record the flow of water, as it may be connected to the apparatus controlling the flow of chlorine automatically increasing the flow of gas as the pumpage increases, and vice versa. This problem will be given attention.

The most modern apparatus and all improvements which past installations have suggested are made use of at the Mayfair station.

It would seem, however, that considerably more experimental work will have to be done with the mechanical devices and that the analyses of the chemical activities of the gas be made as may be required under various conditions. A special study of the chlorine plant at this station will be made with a view of future improvements.

The bacteriological tests made on untreated water during 1916 showed colon present in 1 c.c. in 18 samples out of 1,000 examined, whereas the corresponding number of contaminated samples in treated water during the first nine months of 1917 was 9/10 or less than one per 1,000 samples examined.

During the first nine months following complete chlorination of the water supply the death rate from typhoid fever was reduced by 71.44%. There is, therefore, a strong indication that the use of chlorine reduced the death rate due to typhoid fever more than 70%.

It is our duty, however, to investigate further and to experiment intelligently and scientifically for the purpose of constantly improving our methods with a view of providing pure and wholesome water free from injurious substances.

The Department of Health is exercising a close supervision over the chlorination of the water supply in Chicago, and to this supervision can, to a large extent, be ascribed the gratifying results obtained.

Acknowledgement

The foregoing address was delivered before the Sanitary Engineering Section of the American Public Health Association at the recent annual convention in Chicago.

All States Cooperate in Federal Aid Road Act

Legislative assent, required by the Federal Aid Road Act, has now been given by the legislatures of all states except Alabama. The Alabama legislature meets only quadrennially, and its next regular session will convene in January, 1919, at which time it is expected the necessary legislative assent will be given, according to the annual report of the Bureau of Public Roads of the United States Department of Agriculture. The Governor of Alabama has assented on behalf of the state, as authorized by the act, so that co-operation by the state has not been affected adversely.

American Association of Engineers Urges Chicago Mayor to Recommend Salary Increases for Engineers in City's Employ

Engineers everywhere will be glad to see how the American Association of Engineers is working for better salaries for engineers. Here is one specific example:

On December 21, 1918, a letter signed by Robert W. Shelmire, secretary, Chicago Chapter of the American Association of Engineers, was addressed to Mayor William Hale Thompson and the members of the city council of Chicago. The letter, which was passed by the executive committee and approved by the Chicago Chapter, follows in full:

"The American Association of Engineers, a nation-wide organization of technical engineers, desires to set before you through its Chicago Chapter the unsatisfactory schedule of pay of technical engineers in the service of the city of Chicago, which it expects and hopes you to remedy in the 1919 appropriation bill.

"1. With very few exceptions, almost negligible, the salaries of technical engineers have not been increased in 21 years, or since the civil service law went into effect.

"2. Because increases have been allowed, mostly to union labor, it now is almost the general rule, and has been for the past four years, that the engineers are paid less than the journeymen working under their directions and for whose work they are responsible.

"3. The cost of living has increased abnormally in the last 21 years, and especially during the past three years, and workers in most all lines have received substantial increases to cover the increased cost of living. This has been denied the technical engineers in the city of Chicago's service, on the ground, we are informed, that the city has not the funds. This answer begs the question.

"4. The engineering service of this city is already beginning to suffer because of the above conditions, and as a result the value of service rendered to the taxpayers for taxes paid is growing less. The reason is plain. When a faithful and competent employe realizes that the longer he works for the city, becoming thereby more valuable to the city, and the more experience he acquires, the less he earns, because his salary is stationary, while the value of a dollar grows less, he is forced to leave the service. This, in turn, keeps ambitious men from entering the service, with the result that mediocrity will be all that is left. You usually get only what you pay for. Further, it costs money to train a new man.

"5. The study of the duties of the various grades of the engineering service of the city of Chicago leads this association to recommend the following salaries as being fair and reasonably proportional to those paid by fair employers for similar work:

Grade 1,	Group C,	$150	per month
Grade 1,	Group B,	170	per month
Grade 1,	Group A,	190	per month
Grade 2,	Group C,	205	per month
Grade 2,	Group B,	225	per month
Grade 2,	Group A,	245	per month
Grade 3,	Group C,	260	per month
Grade 3,	Group B,	280	per month
Grade 3,	Group A,	300	per month
Grade 4 and above, not less than $5,000 and up, annually, according to specific position.			

"Specific recommendation will be made on request.

"6. The association is of the opinion that this salary adjustment will increase the efficiency of the service to such a marked degree as to require little or no additional appropriations, because of the economies that will be brought about in the administration of the work done under engineering supervision.

"We are aware that the engineering force of the city of Chicago has done some remarkable work by which it has attained an enviable position in the United States. We ask that you do not allow the city to lose this service by the refusal to provide them with adequate pay.

"8. Please refer this request to the proper committee, with instructions for action.

"The American Association of Engineers is carefully watching the record of elective officials throughout the United States on matters of public concern which are intimately affecting engineers. We trust that Chicago's city government will at this time measure up to its opportunity and perform its manifest duty in this matter."

(While the figures given are of local interest primarily, the purpose of the communication is of universal interest among municipal, county, state and federal engineers, whose salaries of today were fixed by statute or ordinance back in the days of stage coach and the pony express. Engineers who think they are worth more than they are getting will make no mistake in identifying themselves with the American Association of Engineers to work for many good things, including good salaries.—Editor.)

Experience with Sand Clay Road Surfacing in Nebraska

By George E. Johnson, State Engineer of Irrigation, Highways and Drainage, Lincoln, Nebraska

It has often been stated, without just cause, that Nebraska is practically without available road construction materials, but little relative value has been placed on the opportunities afforded by the deposits of sand, gravel, clay and slate found within the boundary of the state.

Where Materials are Found

Sand is Nebraska's most important road building resource, and along with gravel is found extensively throughout the entire area of the state. In considering the problem of road construction, few realize the significant relation the Platte River Valley sand holds towards road building and maintenance. Crossing the state lengthwise, it divides the area near the middle, and places an available building material in a most accessible position for the use of every county throughout the state. It is now considered the largest area of good sand, easily produced, found in the central portion of the United States. By the term, "easily produced," is meant the possible means of transportation, making it available for use in different localities. The valley is well marked with railroads and is crossed with interstate and national highways. The O-L-D Highway enters the state at Omaha and follows the Platte River basin fairly close. The Lincoln Highway enters near Omaha, turns south, and runs lengthwise across the state.

Thus sand, located as it is, near the center of the state, easily accessible by road and rail, becomes a valuable asset in the process of road construction in Nebraska.

But it is not the deposits of sand alone that will make possible extensive road construction. It has been stated by the United States Geological Survey Department that clay de-

posits in some form are always found near sand deposits, and that often the two materials are found in a combination. Along the banks of nearly every small stream in Nebraska can be found either clay or sand, and in many places the two are found together. Clay with varying constituents is found in out-crops in nearly two-thirds of the area of the state, and

UNLOADING AND MANIPULATING CLAY ON SAND-CLAY ROAD CONSTRUCTION—HALL COUNTY, NEBRASKA, FEDERAL AID ROAD.

a mixture composed of fine clay and sand connected with lime and iron oxide is common to the Platte Valley. A gumbo of plastic quality is also located in the Platte Valley.

Properties of the Material

It is generally known that sand makes a better road surfacing when wet, and clay, on the other hand, is in the best condition when dry. With the two properly mixed, the result is the combination of the firmness of the wet sand road, and the smoothness of the dry clay road.

The two qualities of greatest importance found in the sand of a Nebraska sand-clay mixture are: 1, crushing strength; 2, resistance to abrasion.

Sand, naturally, is the only surfacing, if we may call it surfacing, that makes a better topping when wet, than when dry. The sand particles of various size offer a crushing strength and this forms the basic qualities of the mixture. Coarse sand, then, is best adapted to the mixture for sand-clay surfacing.

Clay

On the other hand, clay contains two important qualities: first, binding power, and second, crumbling quality. Clay is usually classified as "ball" or "slaking." The former, as its name implies, is plastic and tends to "lump" or "ball up." The slaking clay is more crumbling in quality and possesses little binding power. Clay varies greatly in density, plasticity, and size of grain in Nebraska. A suitable clay for sand-clay mixture should have the qualities of plasticity—shrinkage and slaking. The ease with which clay, when wet, will mould, and the shape it will retain after dry, determines its plasticity. Shrinkage depends largely upon the fineness of clay particles

SAND-CLAY SURFACE DISCED AND DRAGGED BEFORE FINAL DRESSING OF SHOULDERS AND DITCHES ON SAND-CLAY ROAD CONSTRUCTION—HALL COUNTY, NEBRASKA, FEDERAL AID ROAD.

and their property of drying into a compact mass. The property of crumbling easily, and slaking sufficiently to enable the lumps to break up is desirable in deciding upon the best type of clay for a sand-clay mixture. In Hall County, Nebraska, State and Federal Aid are improving 32.25 miles of sand-clay road; the mixture is natural. A project of 15 miles in Box Butte and Sheridan counties, from Alliance to Antioch, is an alkali clay surface.

The survey of 20 miles for sand clay road has just been completed in Custer and Loup counties, from Sargent to Taylor and Harrop. Garfield county, in the "sandhill" region, boasts of a 20-mile survey made from Burwell to Deverre. Each project is in itself a problem and is being cooperatively worked out.

Mixture of Sand and Clay

Many difficulties arise in the construction of a suitable sand-clay mixture, because of the variation in both materials. However, if the theory of sand-clay roads is carried out, such a type of road will be a success in nearly every locality in Nebraska. What is the theory of sand-clay roads? That the voids between the grains of sand be entirely filled with clay; this theory, if successful, requires unlimited patience in testing and mixing.

Mixing and testing processes are possible in the laboratory and on the road. A very simple test used to determine the

EXCAVATING AND LOADING CLAY FROM RIGHT OF WAY OF CONTRIBUTARY ROAD ON SAND-CLAY ROAD CONSTRUCTION—HALL COUNTY, NEBRASKA, FEDERAL AID ROAD.

percentage of clay to be added to sand in order to acquire a smooth-wearing surface, is accomplished by binding the volume of voids of the sand. By taking a known volume of sand, and determining how much water can be poured into the same space that the sand occupied without running over, the approximate volume of the voids may be obtained, and from this the amount of clay mixed in the mixture approximated.

It has been found that clay in the pure state shrinks often 10% when dried, and if wet again, will expand equally as much. Contraction and expansion may be almost entirely eliminated by the proper quantity of sand being added and mixed with the clay. The sand, being held together by the clay, receives the wear of traffic in weather of little moisture, while in wet weather the water drains off quickly, and the sand again resists the "cutting action" always found in traffic.

Another test that is well known, consists in rolling balls of clay of various constituency, and placing them in a pan of water so that they are half immersed. After several days the clay that will retain its shape, the clay that stands upon form the longest, is of superior quality.

This process may be reversed, and the clay balls be allowed to stand, in order to dry out. The clay ball that shows signs of cracking first is of inferior quality and is poor for the sand-clay mixture.

Putting the two materials together, and depending upon ordinary traffic to mix the materials sufficiently is found to be unsuccessful and impracticable. Harrowing and plowing are absolutely necessary. After the roadbed is finished, it has often been found advisable to add from ¼ to 2 ins. of gravel. This serves to compact the surface and bind together the materials.

The problem of sand-clay surfacing in Nebraska at best, is experimental, and each locality has its own problem to work out. We merely wish to call attention to the possibilities of road building materials found in Nebraska. We have gravel, stone quarries, and sand pits. Earth roads can easily be improved where either of the two materials are found whether in a natural mixture or separately.

Nebraska is not only interested in the improvement of earth roads, but is slowly awakening to the necessity of hard surfacing. Our slogan is *"Pay for Good Roads. Push Good Roads and Progress."*

Road Contractor Successfully Employs Portable Charging Bins to Eliminate Dumping and Wheeling on Subgrade In Concrete Road Construction

By George A. Burley, R. D. Baker Co., Penobscot Bldg., Detroit, Mich.

It behooves the road contractor to invest in labor saving machinery if labor conditions remain in 1919 as they were in 1918. Labor conditions do not appear likely to be improved over last year as it is estimated that 1,200,000 foreign laborers here during 1918 will return to Europe in 1919. Labor saving machinery must be used where possible not only to save money but to eliminate delays due to labor shortage.

Disadvantages of Dumping and Wheeling Material on Subgrade

Of all work in road building that around the mixer is the hardest and the most disagreeable, and it is therefore the hardest operation to maintain at maximum efficiency. Although the highest wages are paid for this work men generally prefer to earn less if permitted to remain on other jobs.

The usual method of handling the concreting materials is to dump the gravel and sand on the subgrade and pile the cement along the berme. The material is brought in by teams, trucks or industrial railway and unloaded and piled in as near the right proportion as can be judged. Next, it is shoveled into wheelbarrows and dumped into the hopper of the mixer.

Every contractor will agree that the wheelbarrow work ahead of a mixer is a man's job and the statement made by a laborer that "The first six months are the worst," is no joke. In the hot sun, when wheeling on planks, or when the subgrade is sandy or muddy, it is not only hard to keep men but harder yet to keep the mixer running to capacity.

It is next to impossible to space the concreting material exactly right as it is unloaded. Either the loads vary in amount or the distance between piles vary with the result that excess material is thrown out on the berme and wasted, or, if not enough material is deposited the wheeling distance becomes so great as to hold up the mixer. To replenish the material, no matter how brought in, will cause a delay until it is dumped and the carrier moved away.

It was eliminating the above difficulties that prompted the R. D. Baker Company to bring out a charging bin eliminating all dumping on the subgrade. With this charging bin the materials are dumped directly into the bins and from these through a measuring device directly into the hopper of the mixer.

The Charging Bins

The method of charging was worked out so as not to change the method of hauling the material from the yards to the mixer by an industrial railway. Standard equipment, namely: 1½ cu. yd. Koppel industrial cars and track and any type of locomotive capable of delivering the quantity required, are used in conjunction with the charging bin. On this work Lima and Plymouth locomotives were used. Also, it is desirable to have a supply of material on hand to avoid stopping the mixer through delay to the supply train, and also to have a method of measuring the material while charging the hopper so as to give a batch per minute. These desirable features are provided for in the design. A Koehring mixer was used here, and the industrial cars were loaded by a Galion unloader.

The accompanying views show a set of the charging bins working on the Dixie Highway north of Flint, Mich. These bins have proved a very valuable addition to the R. D. Baker Company's equipment, promoting both efficiency and economy.

Design of the Bin

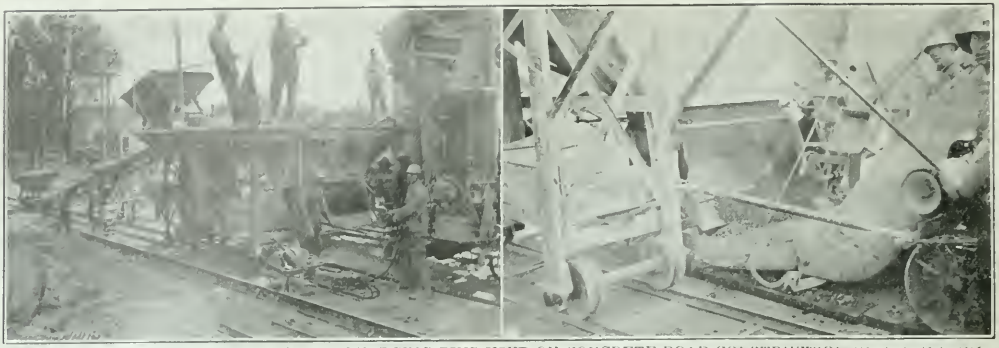
The material bin, built of sheet metal, is divided into two compartments holding 5 cu. yds. of gravel and 3 cu. yds. of sand, respectively. It tapers on all sides toward a rectangular discharge opening at the bottom. Here the material runs into a measuring device consisting of a cylinder divided into four quadrants or sectors, each being partitioned off in proportion to the mix. The one illustrated holds 4 cu. ft. of sand and 6 cu. ft. of gravel. The mix on this work was 1:2:3.

Aggregate Measuring Device

The cylindrical measuring device rotates on a shaft and is held in position by two spring dogs operated by a lever in the hands of the dumping man. The section to be filled comes to a stop under the rectangular discharge opening a little beyond the vertical position, hence, through the action of gravity, the cylinder rotates automatically on releasing the dogs and an empty section moves into filling position.

Cement Handling

At one side the framework is extended and a bin for cement is provided directly under the track. Special car bodies were made to carry cement from the yard. These bodies are of the bottom dump type and are completely covered to protect the cement from the weather. Each car holds 40 sacks of bulk cement. The cement bin slopes on each side to a square opening, and its opening and closing are controlled by a lever. Under this discharge opening is a metal box holding 1 cu. ft. of cement. The box is suspended just above the center on two trunions carried on the end of a lever that



VIEWS OF PORTABLE MEASURING AND CHARGING BINS USED ON CONCRETE ROAD CONSTRUCTION ON DIXIE HIGHWAY AT FLINT, MICH., TO ELIMINATE DUMPING AND WHEELING MATERIALS ON THE SUBGRADE.

General View on the Left Shows Industrial Cars Loaded with Gravel, Sand and Cement Hauled Up Incline to Top of Bin by Spool on Mixer Engine. Materials Measured and Discharged Mechanically Direct Into Loading Skip of Mixer. Close Up View on the Right, Showing Discharge of Gravel, Sand and Cement Into Mixer Skip.

swings horizontally. When the batch of cement is to be placed in the mixer the cement dumper swings the box over the hopper by means of the lever and a pull on a small chain dumps it. When the chain is released the box resumes an upright position and is swung back and quickly refilled.

Moving the Bins

These bins each form a complete unit that can be detached quickly from the supporting framework for shipping, but in moving from place to place on the job the whole charging bin is placed on traction wheels and can be pulled anywhere at will. The framework is made up in complete units and is carried by wheels running on an industrial track. The incline up which the cars are hauled is made in two sections and is arranged to allow for variations in the track when breaking over a hill, etc.

Filling Bins

The filling of the bins is carried on by four men. One takes care of the cement, two the aggregate and the fourth man does the hoisting. There are two independent inclines to the top of the bins and between the rails of each is a plank. A rope is attached to the car and before it is started up the incline a sharp dog is hooked onto the rear axle and allowed to drag behind. This is simply a "safety first" measure; should the car break away from the hoisting cable the dog would stick into the plank and stop it.

The power for hoisting is obtained from a spool geared to the mixer engine, the operator taking about four turns of the rope around it. It is geared so slowly that it does not draw heavily enough on the engine to interfere with the operation of the mixer. The time consumed in hauling up a car is about three-quarters of a minute. As the gravel has almost twice the volume of the sand the cement bin is placed on the sand side. This leaves the gravel to come up one incline while the sand and cement come up the other.

The material track is laid far enough to one side to clear the mixer and another track is laid on the other side spaced to receive the wheels carrying the bins (about 11 ft. centers). One switch and one crossover connect the extra track with the material track having a length between the crossover and the mixer equal to a day's run. The only extra work in connection with the bins that is not required around any mixer where the material is received by industrial cars is the laying of this extra track and this operation consumes only 20 to 30 minutes each day.

The bins are moved ahead by the mixer through two rigid bars connecting them. These bars also give the proper clearance between the bins and the charging hopper of the mixer. No more time is required for each moving operation than to move a mixer without the bins.

Organization of Gang

A Baker finishing machine was used on this work. The following list of men constituted the mixer gang, together with the foreman, and a single horse outfit was used to pull forms and track ahead: 1 finishing machine operator, 1 man placing reinforcement and joints, 2 concrete graders, 1 mixer engineer, 1 mixer fireman, 3 form setters, 3 men on bins, 1 fine grader, 1 cement dumper, 1 winch man hoisting cars; total, 15 men.

Advantages of Bin Method Over Dumping on Subgrade

The following reasons are given as the basis of our statement that this is the best piece of equipment for efficiency and economy that we have acquired. The reasons are based on the methods in vogue in handling concreting material by industrial railway and in operating a concrete mixer:

1. It takes no more men to dump the material into the bins than are required to dump on the subgrade, shovel up and shift the track or pile cement along the berme.

2. In dumping into the bins no material is wasted and there is no shut down of operations due to improper spacing of material on the subgrade. With a full train at the foot of the incline, together with the amount in storage in the bins protection is gained against any delay to the hauling outfit. The amount in the bins will run the mixer 20 minutes.

3. The material is kept absolutely clean as it is not dumped on the subgrade and shoveled up with dirt.

4. The cement is stored at the yard where the cars are filled from the sacks. No cement is lost by exposure to the weather as often happens when it is piled along the subgrade, or lost through tearing of sacks through extra handling. No sacks are lost or wet and the extra handling in picking them up is eliminated.

5. The saving in cost of labor around the mixer.

6. The smaller number of men required in the mixer gang lessens the chance in being held up by labor shortage. It is also easier to get men to work where machinery is employed and only medium work is required.

7. The condition of the subgrade does not interfere with continuous operation. Right after a heavy rain the gang can work as well as in dry weather.

Perhaps the best feature of the bins is the absolute accuracy secured in the measurement of materials. The personal factor of the shoveler is eliminated and this should make the use of the bin appeal to road engineers.

This Time it is Dick, a Pet Alligator

Alligators, generally speaking, are not regarded as good for anything except to provide leather for hand-bags. But Mr.

King, superintendent of water works and sewers at Fort Meade, Fla., has found a novel use for the ungainly creature, according to a newspaper writer. Mr. King, it is asserted trained an alligator to aid in cleaning out 600 ft. of 12-in. sewer pipe after hundreds of dollars had been expended in unsuccessful efforts to remove the obstructions in the pipe line. It seems that one day Mr. King observed his pet alligator, Dick, crawling through a piece of pipe in the back yard. Forthwith, it is related, he seized Dick, tied a rope around his body, and sent him on several excursions through the pipe. Dick learned readily enough to proceed on his way when the rope was given a slight jerk and the rest was easy.

Attached to a stout rope, he was lowered into a sewer manhole and, finding he could not get out, finally proceeded to the next manhole, dragging the rope after him. This accomplished, it was a simple matter to fasten a chain to the rope and by dragging this back and forth remove the congested mass of sand and dirt. Dick has now quite a reputation in south Florida and Mr. King is kept busy shipping him to various points where his services are in demand as a sewer crawler.

Latest Seattle Specifications for Brick Paving are for the Monolithic Type

By W. H. Tiedeman, Assistant City Engineer, Seattle, Washington

I was interested to read an announcement in MUNICIPAL AND COUNTY ENGINEERING recently to the effect that one of our large eastern cities has made an advanced step in its brick pavement construction by abolishing the sand cushion and adopting in its stead a cushion of sand and cement. While this is admittedly an improvement over the old style of work, it can be safely predicted that even this change will not give the perfection hoped for and that further progress must be made.

The Term "Cushion" a Misnomer

The term "cushion" as applied to the medium placed between a concrete base and the brick wearing surface is a decided misnomer and until this is fully appreciated the best results will not be secured from a brick wearing surface.

Physical Variations in Brick

The process of burning bricks involves a tall pile of molded shale, each course of which is subjected to different degrees of temperature and pressure from the overlying load. It will be evident then that with these two variable influences, variable sizes of bricks must result.

In the local material we find that the difference in height of brick blocks, normally 4 ins., ranges between 3½ and 4 ins. for material of suitable hardness for paving purposes.

Why Sand Filled Pavements Fail

A concrete base when finished presents, on its upper surface, a reasonably true plane. If the bricks were laid directly upon this, after set had taken place, it will at once be apparent that with the different sized blocks only a very rough uneven surface could result. The early designers of brick pavements saw this and adopted the logical material—sand—to act as an evening medium. The weight of a steam roller was sufficient to move the sand stratum and by flowing up between the blocks the irregularities were taken up and a smooth upper surface was the result.

The interstices between the bricks were filled with fine dry sand in the earliest work and it is little wonder that the pavement suffered, the brick, however, no doubt getting the blame. With water filtering down between each brick and saturating the sand cushion, each passing vehicle helped to churn the mass and soon the originally smooth surface became rough and the edges of the bricks were noticed to spall or cobble.

Then, in the interest of better sanitation, someone conceived the use of a grout filler. This was an improvement indeed. Even then, an occasional crack in the surface would admit water, and the same trouble began, progressively, from the crack and gradually the loose brick predominated.

Author Prefers Cement Grout Filler

Now I believe it to be axiomatic, that a pavement made of No. 1 brick blocks not held securely, is no better than a pavement of No. 2 bricks bound in some rigid, unyielding manner. Bituminous fillers, while varying in degree of service, are none of them, in my judgment, equal to a Portland cement grout composed of one part of cement to one part of sand. This statement is not based upon any theoretical consideration, but upon carefully-watched experimental strips laid in this city to determine the value of such materials. We have tried practically every commercial brand sold for that purpose and in addition have made mixtures from formulae suggested by the requirements of the case.

Since a grouted pavement should be closed to traffic not less than two months it will be apparent that if a bituminous filler would give equally good results, the earlier opening of the street would be a big factor in its favor. But we have noticed in every case, that the edges of the bricks will crumble because the yielding bitumen does not offer the necessary support for the weakest part of the brick.

Procedure in Repaving a Seattle Street

During 1914 the principal business street in this city was repaved and every improvement known in the art of building a brick pavement was introduced in this work. The original concrete base, having been cut through so frequently for underground work, was found to be hollow in many places and the decision was reached to renew it entirely.

A new base, 6 ins in thickness of 1:3:6 mix, was put down on the thoroughly water settled and rolled subgrade.

Instead of sand, a mixture of one part of cement and five parts of sand was used for the evening course. The sand contained the usual amount of water found in material coming directly from the bunkers. All sand and gravel in this section is washed and separated by hydraulic processes.

The rolling of the bricks had to follow the placing of the sand-cement course immediately, because some "set" took place and rendered the rolling more difficult if delayed.

Temporary Plank Roadway Over Green Pavement

The bricks were sprinkled lightly and the grouting with a 1:1½ mixture followed closely behind. Every precaution was taken to insure good results. The use of the street being urgently needed, required us to cover the completed pavement with a 2-in. layer of sand, upon which new 4x12-in. planks were laid to provide a temporary roadway.

Being a new departure, this plank road upon a brick pavement was the cause of many harmless jests. In no case was the unprotected pavement itself subjected to traffic in less than 60 days after grouting. On the east side of the roadway transverse pre-cast expansion joints were placed, while on the west side these were omitted altogether.

Defects Develop

Six months after the pavement was opened to traffic, we noticed loose bricks appearing at the expansion joints. During the first summer the expansion of this west side (where no joints were used) found expression in a heave at the point where the grade breaks from a nearly level, to a 4.5 per cent. This section was taken up and relaid and no further trouble has been experienced on the west side.

On the east side, however, damaged bricks began to appear here and there all along the street, and at first about 2 ft. from the street car rails. No definite reason can be assigned to this proximity to the street car tracks unless it be that the moving traffic is forced out into the roadway by parked autos which completely and constantly line the curb.

This heavily concentrated loading with one wheel on the street railway portion and the other upon our pavement may in a way explain the breaking down at this point.

Sand-Cement "Cushion" Fails

Repairs were then undertaken and to our surprise the concrete base was intact. The sand-cement "cushion," however, had been mashed where the bricks were loose and beginning with a single loose brick no doubt the trouble would be progressive.

Just why the west side of the street should remain perfect still remains a mystery because the workmanship and procedure with the exception of expansion joints was intended to be identical and was so in reality as far as we know.

While repairs were being made we removed samples of the solid sand-cement sections. Even to the naked eye these are not dense, solid masses. Under magnification, the porosity is very evident, and crystalline forms are visible, possibly calcium carbonate. In mixing the cement and sand, no water was added and the subsequent sprinkling added but little, evidently not enough completely to hydrate the cement. At any rate an imperfect form of mortar resulted and one susceptible of compression and disintegration.

With these facts before us, it seems that perfection cannot be expected in brick pavements laid even on sand-cement "cushions."

Experimental Monolithic Section on County Highway

When the so-called "monolithic" type of brick pavements was first announced, a brick county highway was under contract here and an experimental section about 120 ft. in length of monolithic pavement was laid; this was during August, 1915. Concisely, the specifications for this strip were as follows: Ordinary wet concrete base 5 ins. thick of 1:3:6 mix. Plastic mortar ½ in. thick of 1:3 mix placed upon green concrete. Bricks laid flat upon mortar rolled with a hand roller and grouted with a 1:1 grout.

Section Perfect After Three Years' Heavy Service

This experimental section is on the Pacific Highway and carries a great deal of heavy trucking of farm, truck garden and dairy products. After nearly three years of continual pounding and changes in weather this strip of pavement is absolutely without a single sign of distress and not a loose brick can be found. Just recently we inspected this work and tapped it liberally with a 6-lb. hammer. The sensation was just as if the living stone of the mountains was being struck, so solid did the pavement appear to be.

During 1917, we paved a reinforced concrete viaduct with brick, following the specifications of the county experiment. This also is perfect today and is a section in one of the most heavily traveled highways of this city.

As a summary we now can say that every brick pavement laid upon a sand-cement course has developed transverse cracks and some loose bricks, while those pavements laid upon a plastic mortar are perfectly sound. Now this is either a coincidence or a result which can be expected from the so-called monolithic type of brick pavement construction. In either case the facts justify further work along this line to prove the matter out.

We are not convinced that the thickness of the concrete base should be reduced where "monolithic" specifications are followed because the bond between the mortar bed and the glazed brick is imperfect.

Safe design will still call for a thickness of base sufficient to carry the loads of the road.

In our opinion the real advantage of this new idea lies in the fact that the bricks are bedded in a medium which becomes hard and unyielding. If any real bonding takes place this is incidental and not absolutely essential.

Walt Mason on Good Roads

We've talked so long of shell and shot, of captains and of kings! The time has come at last, I wot, to speak of other things. Let's turn our thoughts from Petrograd to places nearer home; we need good roads and need them bad, and hence this stirring pome. For years we've struggled through the muck, in weariness and grief, and only said, when we were stuck, "It is no time to beef." We floundered through the muddy pools, across the reefs and bars, and lost our horses and our mules, and mired our costly cars. We said, "Until this war shall cease, our woes can't be discust; but, when arrives the dawn of peace, we'll have good roads or bust." We've talked so long of battle fronts that we may find it hard to turn to other, milder stunts; our spirits may be jarred. We've railed so long at Kaiser Bill that we may think it stale to talk of grading down a hill, or filling up a vale. But it is wise to talk good roads instead of bones and blood; the farmers cannot haul their loads because of endless mud. There is no bottom to the pike when comes a sudden shower; I cannot scorch, as I would like, at fifty miles an hour. We've harped so long on treason vile it's hard to break away; but we should talk good roads a while, and start the job today.

Maintenance of Public Utility Plants

By Robert J. Thomas, Superintendent of Water Works, Lowell, Mass.

During the past few years, with the high cost of material and labor prevailing, has the property and equipment of privately and publicly owned and operated utilities been kept up and maintained in good condition for efficient service?

From what is generally known, many of those privately owned plants such as steam railroads and street railroads have depreciated in physical value to such an extent as to be in many cases almost worthless. The common report is that rolling stock, rails and other equipment are sadly in need of renewal. These facts have come to the public notice from the efforts of these companies to obtain an increase in fares, in order that conditions might be improved to some extent. In many cases these increases have come too late and conditions have gone from bad to worse, making the task of placing their property back on an efficient basis very nearly hopeless.

Old Rates Now Insufficient

That publicly owned properties like municipal water works systems have suffered somewhat in the same manner there can be no doubt, especially where water rates were just sufficient to make a works self supporting before the war.

At present their revenue must fall very short of meeting the extraordinary coal and pipe bills, but for one reason or another public attention has not been attracted to this fact. In fact it has always been difficult to arouse public interest in water works affairs, although the welfare of the people is so vitally dependent on good water and its proper distribution.

That the high price of pipe would operate to curtail extension of mains was to be expected. Naturally also, the demand of the government for war purposes operated to prevent pump manufacturers from supplying pumping machinery for new work.

Effect of War Conditions

This, of course, would have very little bearing on maintaining the plant up to standard, but the same cause made it impossible to procure new equipment to replace old machinery which in the interest of economy and efficiency should have been replaced years before. In that respect many water plants will be found in bad condition, so bad that probably in the event of a serious fire the system would break down or be found inadequate.

The fire protection feature of water works systems is also likely to be found deficient through failure of its distributing

mains providing a sufficient quantity of water at the right pressure for extinguishing fires.

Many water works systems have also suffered a loss in their supply of water from driven wells or other sources which the high cost of labor and materials have made impossible or to say the least difficult to remedy. The reduction in the quantity of water can very easily jeopardize the welfare of the people from a hygienic standpoint as well as from a fire protection standpoint, which in the former case would be most serious.

Projects for filtration and purification of water supplies must have been held back and interfered with on account of excessive cost.

Water Works Rehabilitation

If insufficient revenues to meet extraordinary cost of operating and maintaining of water works plants have resulted in deterioration to such an extent as to affect the quality of the water supplied for domestic consumption thereby becoming a menace to the public health, it should be of far more concern than the condition of transportation companies.

With the extreme importance of this in mind, it would seem that in the days of reconstruction following the war, much attention and thought should be given to water plants and that considerable money must be provided for their rehabilitation. The more so because generally no increase appears to have been made in water rates by municipalities.

Performance of the Ransome Drifting Sand Filters at Toronto, Ontario

Among the water filters placed in operation in 1918 are the Ransome drifting sand filters at Toronto, Ont. The present account of the operation of these filters was furnished the Committee on Water Supplies of the American Public Health Association by Joseph Race of Ottawa, Ontario.

The general design of this plant has been given wide publicity in the engineering journals and no further details are necessary. The main features of the plant are the elimination of the coagulation basin and the substitution of a bed of sand having a moving conical surface for the usual stationary bed. The effective size of the filter sand is 0.35 m.m. and the

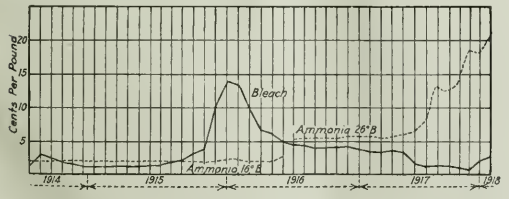


DIAGRAM SHOWING FLUCTUATIONS IN BLEACH AND AMMONIA PRICES AT OTTAWA, ONTARIO, 1914-18.

uniformity coefficient 2.0. Owing to the conical shape of the sand surface presenting a greater area, the capacity is increased; the normal rate being 2.9 U. S. gals. per minute per square foot plan area of filter, or 1.45 U. S. gals. per minute per square foot of effective filtering area.

The elimination of the coagulation basin has introduced no difficulties; the efficiency of the filters is high and no hydrate of alumina appears in the effluents.

Plant Fulfills Requirements

The official test of the efficiency of the plant has been completed and the city officials have certified that it has fulfilled the following requirements with the use of not more than 0.8 grain of alum per U. S. gallon under average conditions:

(a) To remove 90% of all organisms where there are 50 to 500 bacteria per cubic centimetre in the unfiltered water;

(b) To remove 95% of all organisms where there are 500 to 2,000 bacteria per cubic centimetre in the unfiltered water;

(c) To remove 98% of all organisms where there are 2,000 or more bacteria per cubic centimetre in the unfiltered mater;

(d) To remove 98% of B. Coli as determined by the Standard Methods for the examination of water of the American Public Health Association.

(e) To remove all turbidity leaving a bright colorless water free from taste.

The capacity was guaranteed at 72 million U. S. gals. per 24 hours, for continuous operation with a maximum of 86.5 m. g. d. over a 10-hour period. This condition was also fulfilled.

The initial loss of head in the filters is 6.0 ft. and runs of 14-17 days can be obtained before back-washing, which is neecssary when the loss of head reaches 10.5 ft. The backwash is made with water only, the maximum vertical velocity being 1.7 ft. per minute. The percentage of wash water is 3 per cent,, 1 per cent. only being filtered water.

Plant Accepted By City

The first units of the plant were placed in operation early in 1917, and the plant has been in full operation since March 31, 1918. The City of Toronto, after consideration of the reports of the Commissioner of Works and the Director of Laboratories, has accepted the plant as being entirely in accordance with the specifications and has taken over the control of it.

The final cost works out at $14,900 per million U. S. gals. normal capacity.

The only serious difficulty encountered during the construction of the plant, apart from delays caused by the war, was due to the failure of sub-contractors to deliver sand of the desired grade. The sand delivered contained an excess of fine material which had to be eliminated before the desired length of the filter run could be obtained.

Chloramine Treatment at Ottawa

Mr. Joseph Race also reports as follows on chloramine treatment at Ottawa:

This treatment has now been in operation for over 18 months and has given very successful results. With bleach a minimum dosage of 0.75 p. p. m. of available chlorine was required, but with chloramine this can be reduced to 0.25 p. p. m. with 0.06 p. p. m. of NH^3 when the temperature of water approaches the freezing point and to 0.5 p. p. m. (plus 0.06 p. p. m. NH^3) when the temperature is 75 to 80 degrees F. One excellent feature of the treatment is the absence of after-growths which are very marked during hot weather when bleach only is used.

The economical aspect of this method has entirely changed during the last twelve months and the cost is now greater than that of straight bleach. This is due to the rapid advance in the price of ammonia as shown in the accompanying diagram.

Taking a Chance With An Unsafe Water Supply Proves Costly

Imperfect disinfection of a portion of the public water supply of Xenia, Ohio, was responsible for the outbreak of 44 cases of typhoid fever in that city during the last few days of August and the first half of September, 1918, according to investigations made by representatives of the Ohio State Department of Health, as reported in the Ohio Public Health Journal for November. The fault, it was found, lay with a defective supply of bleaching powder, the substance used as a disinfecting agent.

Typical Water Borne Typhoid

All epidemiological evidence disclosed by the investigation

pointed to the water supply as the source of infection. Cases were widely distributed over the city and city water was used at home by all but one patient, who used it only at her place of business. A study of the occupations of the patients revealed no similarity in this regard. Milk, ice cream and fresh vegetables were used in varying quantities and obtained from many sources. None of the patients had eaten any raw shellfish recently before falling ill. No public gatherings had been attended by patients recently enough to be suspected as sources of infection. Contact infection as an important cause is ruled out by the facts that only eleven patients resided in homes where other cases developed either before or after the case in question and that only two households had as many as three cases each.

Public Water Supply Privately Owned

The Xenia water supply is furnished by a private company. It is derived from two sources—a system of drilled wells southwest of the city and a combined surface and ground water supply obtained from reservoirs, springs and dug wells north of the city. The surface and ground water supply was installed in 1887 and remained in use after the drilled wells were installed in 1896, because the latter source was insufficient to supply the city.

Water from the drilled wells has always appeared satisfactory from a sanitary standpoint. That pumped from the station north of the city has been shown at several times to be unsatisfactory, in consequence of which a hypochlorite disinfection plant was installed in 1914. On the average two-thirds of the city's water comes from the drilled-well source and one-third from the disinfected supply, the amount pumped from the drilled wells becoming relatively smaller in dry weather. This variation makes it impossible to determine just what part of the city is being supplied from each source at a given time, but the presence of a large amount of iron in the drilled-well water makes a reasonable degree of differentiation possible.

Hypo Below Guaranteed Strength

Disinfection of the water at the north pumping station had been carefully conducted, according to the report of the Department investigators, who found that bleaching powder had been added in definite, prescribed quantities for 2½ years. Analysis of water samples collected in the city, however, demonstrated that the water from this station was of doubtful and unsatisfactory quality, while that from the other station was satisfactory. This led to an analysis of the bleaching powder, which was found to be of one-fifth guaranteed strength.

Liquid Chlorine Recommended

"Since this substance was guaranteed to be of proper strength," says the report of the investigation, "it follows that the undertreatment of the city water was purely accidental; nevertheless, it is significant that such a possibility always exists when disinfection of a public water supply is necessary to render it safe for domestic use. In order to avoid the recurrence of a polluted water being supplied the consumers at Xenia, the water company should abandon the existing supply at the Springfield Pike station (the surface and ground water source) and procure water of satisfactory sanitary quality from another source. In the meanwhile it is advisable that the company abandon its hypochlorite method of disinfection and employ the more dependable and up-to-date method of using liquid chlorine."

Methods Employed in Lowering a 12-in. Water Main Under Full Pressure

An interesting account of the lowering of a 12-in. water main while under full service pressure is contained in the annual report of the water commissioners of Middletown, Conn. In all 1,500 ft. of the big pipe were moved to conform to a new street grade.

A profile of the pipe line was obtained by digging test holes over the water main at stations, of the survey made for the improvement of the street, and running levels. The profile of the water main thus obtained was very irregular and far from being parallel with the grade of the street. At many points it was indicated that it would be necessary to lower the main a maximum of 2 ft. in order to bring it with its gates and services below frost line, and that the total length to be lowered would be about 1,500 ft.

Renewing and Lowering Service Connections

All of the services in the street which had not been renewed in recent years were renewed with lead-lined pipe and lowered. After this was completed a trench was dug along the 12-in. water main down to the proposed new pipe grade at each joint and wood blocking placed under each joint. The earth was then excavated between joints to pipe grade.

First Method

The first section to be lowered was 700 ft. long. The water main and a hydrant were lowered by means of jack screws placed in pits under the spigot end of each joint with wood blockings.

The lowering of the main in this section was successfully accomplished with the water mains under pressure and without cutting the water main or hydrant branch. The joints were of the usual bell and spigot type with 3-in. sockets caulked with oakum and lead. This pipe was originally laid in 1896 and the exterior of it was as good as new; in fact, some of the paint markings upon the pipe were as bright as the day it was placed on the pipe.

Second Method

During the process of lowering this pipe no trouble was experienced with leaks. It was apparent that the method of using jack screws and blocking and the necessary jack screw pits could be improved upon in the next section of 800 ft. Therefore chain hoists with 6x6 timbers laid across the trench as supports were used in lowering this section, in which were two intersecting street mains and one fire hydrant. This method was a saving over the jack screw method, in excavation, cost and time of lowering, as it was much more rapid and it was useful also in assuring the safety of operation. The greatest number of hoists that were used simultaneously was four. This method proved to be very successful from every point of view, and no trouble from leaks was experienced in this section. It was not necessary to disconnect or cut the main and hydrant branches and street branches to be lowered, and the mains were kept under full service pressure. It was necessary to disconnect the house services for only short periods. All of the gate valves in this section were carefully inspected and spindles repacked and all pipe joints were recaulked.

Effect of War Conditions on the Operation and Maintenance of Water Works

A comparison of the conditions under which water works were operated in normal times, with those prevailing in war times is going to reflect great credit on water works operators in general, who have exerted every effort to maintain their standards of quality and service in spite of the diminishing number of experienced and capable assistants and employes, in the face of steadily and rapidly increasing costs of materials and labor, and regardless of the loss in revenue, says the report of the Committee on Water Supplies of the American Public Health Association. Edward E. Wall, Water Commissioner of St. Louis, was acting chairman of the committee.

The general disposition of Public Service Commissions and other bodies controlling rate-making has been in the direction of fair dealing, and favorable towards granting increases in

rates where the applicant was able to establish the justice of his case.

Cost of Principal Materials and Supplies, 1914-1918

The committee obtained from 34 cities figures on the cost of a number of the principal materials and supplies used by the water works, for the years 1914 to 1918 inclusive.

These prices, with the exception of those for unskilled labor, when reduced to a common basis by eliminating differences in freight charges and allowing for reasonable variation in prices because of quantity purchased, show marked increases in 1917 and 1918.

The following tabulation may be taken as a composite set of prices typifying the increases from year to year averaged and weighted from the figures given by the 34 cities:

	1914	1915	1916	1917	1918
Coal, per ton	2.90	3.00	3.10	5.00	5.40
C. I. pipe, per ton	26.00	26.00	30.00	50.00	60.00
C. I. Specials, per ton	54.00	54.00	60.00	90.00	115.00
Fire hydrants, each	33.00	33.00	36.00	50.00	60.00
4 in. valves	7.00	7.00	8.50	11.00	14.00
6 in. valves	11.50	11.50	12.00	17.00	22.00
12 in. valves	33.00	33.00	37.50	55.00	77.00
Sulphate of alumina, per ton	26.00	26.00	40.00	40.00	40.00
Sulphate of iron, per ton	17.00	17.00	18.00	21.50	26.00
Lime, per ton	8.00	8.50	9.00	10.50	13.50
Liquid chlorine, per pound	.15	.18	.14	.19	.15
Hypochlorite of lime, per ton	42.50	56.00	90.00	80.00	82.00

Labor Conditions

The advance in the cost of unskilled labor has been particularly marked in the latter part of 1917 and in 1918. The prices paid in various localities vary widely, due no doubt to differences in the local conditions of supply and demand.

Evidently during the past twelve months the abnormally high wages reported to be paid at construction camps and munition plants has induced labor to leave the lower paid jobs at water works and other utilities. In general it may be said that the advance in wages of unskilled labor over the prices current in 1916 ranged from 10 to 20 per cent. in 1917, and from 30 to 50 per cent. in 1918.

UNSKILLED LABOR PRICES PER HOUR

	1914	1915	1916	1917	1918
Range from	10c to 30c	12½c to 31¼c	15c to 33c	17c to 40c	25c to 50c
Weighted averages..	22	22½	25	27½	35

It is also noteworthy that it is almost the universal opinion that this class of labor has shown a very marked decrease in efficiency, which adds very materially to the expense of operation and maintenance.

The increase in wages of unskilled labor is only a portion of the story. Firemen, oilers, engineers, machinists and all artisans demand and receive heretofore unheard-of wages, adding their quota to the already overburdened water works. Many of the technical men, civil and mechanical engineers, chemists and superintendents, who have not joined the army, received such flattering offers to enter other fields of work, that the water works operators were hard put to it to maintain an adequate organization.

Danger to Public Health

The operators have naturally reduced their working forces to a minimum and have voluntarily abandoned construction work wherever possible, irrespective of the government restrictions on materials. *Herein lies the danger to the public health, that the inadequacy of many water works will not be apparent for some time to come, at which time it will be impossible to repair the deficiency quickly enough to avert a serious falling off in quality and service, both on account of a lack of funds and because of the impossibility of immediately procuring new machinery, materials and competent labor.*

This feature of the general situation is a very serious one, for which there appears to be no practicable remedy available, except for those fortunate plants whose revenue is sufficient to meet war-time extraordinary expenses and still have left a surplus to devote to additions and betterments as far as materials and labor can be procured. Those less fortunate should use every effort to obtain such relief through the Commissions and Boards controlling rates and service, that will enable them not only to meet the abnormal conditions, but also to prevent any later falling off in service.

Guarding Works

Just after the United States entered the Great War, there were issued by the War Department orders to guard water works along with bridges, factories, public buildings, etc., and soldiers were detailed for this duty in many places. About August 1, 1917, the soldiers were withdrawn from most water works and the operators notified that they must protect their property at their own expense.

In the face of the government's action in originally placing the guards and later advising their continuance, no water works engineer or superintendent felt like assuming the responsibility of dispensing with guards after the soldiers were withdrawn, although all of them were thoroughly convinced that the protection afforded by the few guards which could be employed would lie more in the moral effect of their presence, than in any actual resistance they could offer against an organized attack.

Many pumping stations were inclosed with barbed wire fences, guards posted and patrols established. Most of these are still maintained, although generally with decreased forces.

Out of 30 cities reported to the committee, guards were maintained until the signing of the armistice at 26, although from only one city has there been reported any attempt to damage the works. The guards could prevent any attempt by a single crank or fanatic to dynamite pumps, conduits or reservoirs, but would be powerless to baffle any well-laid plan of an organized band seriously bent on disabling the works.

Filtration and Disinfection

Although conditions in 1917 and 1918 have been most unfavorable for extensions, additions and improvements to water works, a number of filter plants have been built, one company reporting a total of 25 new plants with a total daily capacity of 52,700,000 gals., supplying an estimated population of 366,000.

Reports from the State of Kansas show that new filters were built or additions and improvements made to existing filters at 10 water works out of a total of 32 cities reported as supplied with water from rapid sand filters.

The information furnished the committee from various cities as to the difficulty of maintaining the standard of quality during the war, indicates that such a standard is being generally maintained, and an improvement effected in those cases where the tests for B. Coli fell below the standard set by the U. S. Treasury Department for water supplied to common carriers.

The use of hypochlorite of lime or liquid chlorine has been almost universal for sterilization, and practically every filter plant uses one or the other, with a rapidly growing tendency toward the use of liquid chlorine, because of its being better adapted for transportation, storage and application. The average cost of sterilization with liquid chlorine for the year 1917 is reported to have been 37 cents per million gallons.

Chlorine in its various forms seems to be the most commonly used germicide in the treatment of water for field forces although permanganates, bromide and iodine are also used. Some of these are prepared in tablet form, especially suitable for cavalry, one of these being a complex chloramine, known as "Halazone."

The desirable thing in field water purification is that the agent should act effectively in a very short time, leaving no objectionable odor or taste, nor creating any harmful chemical compound by its reactions. After the peace treaty is signed we will doubtless be informed of many new and ingenious devices and improvements in methods which are not permitted to be published at present.

Drainage District Advocated as Solution of the Mahoning River Sanitary Problem

The pollution of the Mahoning River in the vicinity of Youngstown, Ohio, with consequent danger to the health of the several communities bordering on the stream, has given rise to a sanitary problem considered by the State Department of Health to be one of the most momentous with which Ohio has had to deal. After the failure of efforts to remedy the situation by individual action on the part of the several municipalities and industrial concerns involved, the decision has been reached, says the Journal of the Board, that the only effective means of settling the matter will be by the organization of a sanitary district through which the various political units can act collectively and therefore effectively. Accordingly, it is expected that the General Assembly will be asked this winter to pass a bill making possible the organization of such a district. The proposed bill, which is being drawn up by the department, is modeled in a general way after the Conservancy Act.

The combined effect of sewage and industrial wastes discharged into the Mahoning River from the several municipalities and industrial establishments from Warren to the Ohio-Pennsylvania state line, renders the river an unsatisfactory source of municipal water supply even where the water is treated by means of modern purification works and causes serious pollution of the stream during periods of normal dry weather flow to such an extent as to make it objectionable to the inhabitants of the district. The rapidly increasing degree of pollution resulting from the growth in population and industrial development will, in all probability, overcome the beneficial effect brought about by the increased minimum flow as a result of the construction of the Milton Dam and impounding reservoir. The condition of the river is serious and steps should be taken without delay to adopt corrective measures if the health and comfort of the citizens in the district are to be safeguarded.

As a number of the municipalities are contiguous and others nearly so, it is essential that the correction of the pollution of the river be considered as a district problem. A thorough and comprehensive study of the disposal of sewage and industrial wastes and of water supplies should be conducted jointly by the several political subdivisions and industrial establishments in the district for the purpose of determining existing conditions and the most satisfactory remedies in the improvement of water supplies and the disposal of sewage and industrial wastes.

Utilizing More Mechanical Devices on Road Construction

By Frank F. Rogers, State Highway Commissioner, Lansing, Mich.

The cost of materials and labor entering into road construction have advanced to such high figures that in many localities it has been a question of attempting to save in the cost of labor or practically discontinue road building. In Michigan the sentiment for good roads is so great that it would have been impossible for the State Highway Commissioner to stop road building entirely during the war period even if he had attempted to do so. In fact, there never was so much money available for road building purposes in Michigan as during the past year, said Mr. Rogers, in addressing the American Association of State Highway officials.

During the fiscal year ending June 30, 1918, only 793 miles of state reward roads were approved, showing a slow down over the previous year of approximately 25%. However, the first five months of the present fiscal year ending November 30 shows a total of 560 miles of road accepted, as compared with 391 miles during the same period of 1917 or a 43% increase over the previous year, in spite of all the war time handicaps.

Peculiar Economic Conditions

Indeed some peculiar economic conditions have manifested themselves. In most localities in Michigan there was a surplus of team labor and a great dearth of manual labor. In one county the commissioners reported more available labor than during any of the past three years. This was attributed to the fact that many retired farmers who heretofore had ample incomes from their farms, now, due to the high cost of living, found it necessary to supplement their farm incomes with more or less manual labor. These men were all past middle age and the inducement of very high wages for manual labor, from 35c to 50c an hour, doubtless had some influence in inducing them to become day laborers.

I do not know that anything new or startling has been used in Michigan by way of labor saving mechanical devices but a few things are worthy of note.

Tractors

In grading operations tractors have largely superseded horse power. Tractors were not only used for hauling blade graders, but ditching has been successfully done with the Ford tractor and flat board scrapers. A scraper was hitched to each end of the tractor which has a very short wheel base. The tractor then was moved across the road alternately forward and backward, but with a slight angle to the center line of the road so as to "cut over" the width of the scraper with each move. As the tractor moves ahead the scraper hitched to the rear end draws a full load up onto the road grade while the scraper hitched to the front end is backed to the ditch and vice versa. This way of using the tractor is said to be much more rapid than the work of two teams.

Grading has also been done with the same type of scraper by using a small gasoline reversible hoist placed on a truck stationed in the center of the road grade. A scraper was hitched to each end of the cable, the center of which was wound on the drum so that as one scraper was drawn out of the ditch with a full load the other was released and backed to the ditch and vice versa. This method of grading has also been quite satisfactory.

Steam Shovels

Steam shovels have been used quite extensively in road grading, not only where the excavation is heavy but sometimes on rather light work, where not more than a foot or even less had to be scalped off from the old grade.

Mechanical Hauling

Mechanical power for delivering materials to the roads has been used quite extensively and ranges from the motor truck to the industrial railway. In fact it may be said that mechanical hauling has very largely displaced team hauling on Michigan roads. I have in mind one case where a motor truck is making five trips with 3 cu. yd. loads of gravel on a haul so long that teams working on the same job, make only two trips with 2 cu. yd. loads, the truck delivering 15 yds., as compared with 4 yds. for each team. It should be remembered, however, that truck hauling is not a success on heavy grades nor in loose sand or deep mud.

The industrial railway has been used very successfully on long hauls and on light grades. Wayne County and Delta County and some contractors have used the industrial railway with much success.

Motor Haulage

L. E. Adams, County Highway Engineer of Alger County, Munising, Michigan, reports: "We have been using the motor truck for the transportation of materials along the highway in the construction of macadam roads, for the past four years, and find a great saving in cost over team labor. The cost of truck hauling is less than one-half the cost of team hauling. We like the four-wheel drive truck for dragging earth and

gravel roads and for general maintenance work. The heavy five-ton trucks are used only on construction work, for they move much slower than the lighter truck."

K. I. Sawyer, County Road Engineer of Marquette County, Ishpeming, Michigan, reports: "Our road grading has been done the past season, using a Fordson tractor to haul the road machinery. This substituted one man and the machine for two or three teams. It is impossible to make a cut equivalent to three teams, or for that matter hardly equivalent to what two teams would do, but the speed of the work is such that by making lighter cuts and more of them, work equivalent to a three-team grader outfit has been accomplished.

"One of our drag men also uses a Fordson tractor in his dragging operations. I am not satisfied as to the advisability of this for where there is a crust on the road, as in sand-clay construction, the question arises as to whether the lugs on the wheels do not do as much damage as the dragging does good.

"The county operates one surfacing truck which is driven by the maintenance superintendent. This enables him to cover all his work and at the same time deliver the necessary supplies and small equipment from our warehouse to the various maintenance and construction jobs. An ordinary Ford runabout with a jump box is used for this purpose. It does away with practically all supply teams as well as placing one man in a position to keep constant check on maintenance operations.

"In our surfacing operations in 1916 we employed 17 men and 5 teams including roller men, foreman and cook. The past year we employed a maximum force of 8 men, including foreman and roller men, and one team and laid approximately double the amount of stone on longer hauls. The wife of one of the roller men served as cook, which was only made possible on account of the small crew.

"The machinery used on this job was as follows: one hand pump; a 6 H. P. Fairbanks gas engine; a 250 gal. Morse centrifugal pump, both mounted on one set of skids and belt connected. The same apparatus was used for pumping water for sprinklers and pumping bitumen from tank cars into the tank wagons. A motor truck also was substituted for four teams. An endless belt conveyor of the grain type without buckets was used for unloading the stone cars. This took the place of six men while the spreading apparatus on the truck cut down the necessary spreading crew. The roller crew remained the same, but because of better watering conditions, one sprinkler with a team proved all that was necessary except on long hauls or in exceedingly dry weather. When water had to be pumped by hand two teams and two extra men were required for the same work. I might add that we resorted to winter hauling on a considerable portion of our gravel surfacing work in order to cut down the cost and I am nearly convinced that winter hauling with team and spreader will compare favorably with motor truck hauling in summer."

Concreting Plant

The R. D. Baker Company of Detroit on the North Saginaw road in Genesee County, in laying 10½ miles of 18 ft., reinforced concrete on a 30 ft. roadbed, costing $270,000, developed a construction plant, where the aggregates were dumped from cars and motor trucks into a power loader, elevated to storage bins, loaded into 1½ cu. yd. dump cars, hauled in trains on a portable 30 in. gauge track by a motor engine to the concrete mixer, where the cars were hauled up an incline track by cable and the aggregates dumped into a segmental revolving drum, each segment containing one "charge" of coarse aggregate, and one "charge" of fine aggregate, which was automatically measured and dumped into the charging hopper of the mixer. The Portland cement in bulk was loaded into a covered car transported and elevated in the same way, from which it was measured in a swinging dump box, and dumped into the charging hopper immediately following the aggregate.

This plant reduced labor to a minimum, and made it easier while the aggregates were kept clean, and the sub-grade perfectly maintained.

Camp Cars

C. F. Winkler, County Road Engineer of Gogebic County, writing regarding road maintenance, says: "The past summer I had built two sets of car camps on wheels, two camps in a unit, a cook and sleeping camp. These with two tractors have maintained our road from Bessemer to the Iron County line, a distance of approximately 70 miles, as never before and at a saving of the cost of the tractors. In other words I figure one summer's work will pay for the tractors.

"Most of this distance, as you know, is through virgin timber, where camping facilities are at a premium and usually five to seven miles from the work.

"The camp car is, as all know, no innovation, but with tractors a move can be made every day if necessary, thus keeping the crew within easy working distance of the job, hence the economy of this plan."

Concrete Roller

J. W. White, County Highway Engineer of Monroe County, Monroe, Michigan, reports the use of a novel concrete roller as follows: "Our first concrete roller was a small one, made of 2-in. plank, 3 ft. in diameter and 15½ ft. long and weighed 2,200 lbs. This roller had a tendency to make the concrete wavy, which was attributed to the small diameter, so we had a larger one constructed with a diameter of 5 ft. and weighing only 2,000 lbs. The surface of both rollers were concave so as to give the required crown to the roadbed.

"We find that rolling compresses a 5-in. slab of concrete between ¼ and ⅜ in. We have rolled ten miles during the season just closed, and if the above statement is correct on the basis of ¼-in. compression, we have squeezed 657 cu. yds. of voids and water out of the 5-in. slab. This statement sounds rather large but seems to be backed by facts.

"The larger roller is made of steel and cost a little over $400. It has not added $1 to the construction cost of the road other than the initial cost of the roller and our experience would indicate that one roller could be depended upon to roll several hundred miles of concrete without wearing out.

"The surface of the rolled slab is as true as the average concrete road surface. The roller picks up the mortar just enough to leave a pebbled effect which forms an ideal base for the asphalt top.

"In the finishing operation we have a templet which rides on the forms and is dragged ahead by the mixer. When 15 or 20 ft. of concrete have been spread the roller is rolled back and forth an average of three times.

The size of the roller gives it the appearance of being very cumbersome, but it is easily rolled by hand by the two men whose duty it has been to put the finishing touch on the slab.

"We have constructed approximately 40 miles of concrete road in Monroe County in the last three years and until we hit on the idea of rolling to get a well compacted concrete our work was in spots very unsatisfactory."

Sluicing and Washing Gravel

Alex. McKay, County Road Engineer of Calhoun County, explains a method of obtaining road gravel by sluicing and washing as follows: "The washing plant is now at its fourth location. I have no definite data regarding the first two sets, as to amount of material moved to secure the gravel. On the first location we were able to secure an average of 100 cu. yds. per day for most of the time, but the later sets have been in more difficult situations.

"At the third set north of Bedford, work began March 19, 1918, and ended August 31, 1918. The prospect was so poor

that we located at that point only after every other prospect had been investigated and we had spent over $100 digging into every hill and running down many reports within a radius of three miles. The pit was cross-sectioned before and after working, thus the figures as to yardage moved are quite accurate. All the gravel was hauled by the yard so we have another check on the total amount of material secured.

"The largest day's run was 44 yds., and the smallest 15 yds. Men employed were foreman at $5, engineer at $3.50, hoseman and general helper, each at $3. About 28 gals. of kerosene were used each day in two engines. A 15 H. P. engine ran a 3-in. centrifugal pump, giving approximately 250 gals. per minute at about 20 lbs. pressure at the nozzle through 500 ft. of 6-in. spiral pipe. A 6 H. P. engine was used to run a revolving screen and elevator. A bar "grisley" on top of bins removed oversize stone. Water was secured from a nearby creek. Our fine screen was a square mesh of 1 16 in. opening, but there was very little fine sand carried over.

Total days worked, 10 hrs. each	131
Total yds. gravel secured	3,200
Average daily yardage	25
Average daily cost of operation	$19.16
Total cost of operation	$2,511.81
Total yards moved from pit	10,500
Average cost per yard in bin	$ .78

"After getting all the available gravel in that location we moved the plant to the fourth or its present location, 1½ miles farther from the road. This pit was much more stony and required an additional man to fork stone away from the sluices. This pit had been worked two years before and abandoned on account of the large amount of oversize stone and number of sand pockets.

Total cost of moving	$162.00
In operation from Sept. 6 to Nov. 15, total number of days worked, 10 hrs. each	56
Total yardage secured	2,036
Average cost per day	$21.00
Average yardage per day	36
Average cost per yard, in bins	$ .59

"It will be noted that no depreciation of machinery is figured. The total plant cost is around $2,500. Our experience with washing gravel has been that we can work over a large amount of poor material and secure a good road building metal at reasonable cost. We cannot compete with good pits located advantageously with this small portable outfit unless due credit is given for the excellence of the material thus obtained."

I regret that lack of time has made it impossible for me to go into this subject more thoroughly, for I have found it very interesting, although I presume that reports from other states as to mechanical devices used would be fully as interesting as anything I have been able to offer.

The Federal Aid Road Law; Experience to Date and Suggestions For Better Co-operation

By the Late Logan Waller Page, for Many Years Director of the U. S. Bureau of Public Roads

(Editor's Note:—The following paper was prepared by Mr. Page for presentation at the Fourth Annual Meeting of the American Association of State Highway Officials, held in Chicago, Dec. 9-13, 1918. The paper was on the program for Dec. 13. Mr. Page died at his hotel in Chicago on the evening of Dec. 9. A few days before the convention Mr. Page sent the editor a copy of his paper and some photographic views on federal aid work. The paper is published here, with the consent of the secretary of the association. It was one of the last messages of Mr. Page to his contemporaries, and will stand as his valedictory to the workers in the highway field.)

The passage of the Federal Aid Road Act and the entry of the Federal Government into the field of road construction and improvement in 1916 in co-operation with the several state highway departments marked the beginning of an entirely new undertaking. There were no precedents to follow, no established procedure. Every step had to be blazed over new and untried ground. Moreover, the Federal Aid Road Act came into existence at a time when the effects of the great war were beginning to be seriously felt, especially in regard to the supply of labor and materials. A few months later our own entrance into the war still further increased these abnormal conditions.

The adoption of conservation measures by the Government to insure prosecution of the war program neecssarily imposed restrictions on road construction and kindred operations. The great demand for labor curtailed the supply available for road work and caused an abnormal advance in the price to be paid therefor. The Government demand for materials in connection with the stupendous war preparations made it imperative that the use of such materials for undertakings not directly connected with the war program be restricted. As a result of these necessary restrictive measures, steel, brick and cement could only be obtained for such projects and in such quantities as might be approved by the War Industries Board; bituminous materials could be secured only with the approval of the Fuel Administration; needed railroad transportation could only be obtained subject to the various priority orders and other restrictions of the Railroad Administration; and where the funds for improvements were to be raised by bond issues, the approval of the Capital Issues Committee was required. With a view to co-ordinating the regulatory activities of these several governmental agencies, the U. S. Highways Council was organized by the Secretary of Agriculture. Your familiarity with the organization, personnel, and operations of the council make it unnecessary for me to dwell upon its activities. With the cessation of hostilities, an early amelioration of these adverse conditions may be expected, but in order to judge fairly of the success of Federal Aid in road construction and improvement during the two years of its operation we should take into consideration these two facts—first, that it was an entirely new function of the Government, and, second, that it was launched and has so far continued under the most abnormal and difficult conditions that could be imagined.

Accomplishments

Notwithstanding the difficult conditions which so far have beset the operation of the act, results have been achieved which are at once definite, tangible, and full of promise for the future. From the passage of the act to November 15 of this year 730 projects have been approved by the Secretary of Agriculture. These projects involve the improvement of 7,689 miles of extremely important public roads. The total estimated cost of these projects amounts to $55,777,208, a sum equal to one-fifth of the total annual road and bridge expenditures of the entire United States during a normal year. In the construction of these projects, the share to be borne by the Federal Government amounts to $20,900,805. Had it not been for the uncertainties and difficulties imposed by the war, I feel sure that every cent of the total $29,100,000 of Federal funds available for expenditure on construction would have been definitely obligated and most of the work well under way.

I cannot speak of these accomplishments without feeling that too much credit cannot be given to the several state highway departments for their helpful co-operation and assistance in carrying out the provisions of the Federal Aid Road Act and in meeting and overcoming the difficulties encountered. As a result of the spirit of helpful co-operation displayed by

the several state highway departments, it may be mentioned that of the total number of projects submitted only seven have been definitely disapproved by the Secretary of Agriculture.

Difficulties Encountered

I think it well to mention somewhat in detail some of the difficulties which have been encountered. Of course, as I have already stated, the most serious obstacles have resulted either directly or indirectly from the abnormal war time conditions. I perhaps would be justified in saying that 90 per cent of the difficulties experienced in carrying out the construction of Federal aid projects have been due to the difficulty of securing materials, transportation and labor. No section and no state has been free from these difficulties, which, moreover, have not been limited to Federal aid road work but

VIEWS ON VARIOUS FEDERAL AID ROAD PROJECTS.

Top Row: 12 ft. Warrenite Road, Camp Pike, Arkansas—Main Span of Concrete Highway Bridge near Sanborn, Minn. Bottom Row: Building bridge across Cass Lake in the Minnesota Natural Forest—Cass Lake Bridge nearing completion.

have applied equally to work of all other classes. But since these difficulties will now no doubt rapidly disappear, we need not dwell upon them, but may be thankful that they were not worse and that they happily are a thing of the past.

There have appeared from time to time, however, a number of minor obstacles due to the inherent difficulty of organizing and getting under way an entirely new program. Through the assistance of helpful criticisms and suggestions from the various state highway departments most of those have been eliminated, and it is my sincere hope that with the continued assistance of the states all such difficulties may soon be entirely removed. It, therefore, may be well to review these difficulties somewhat more in detail.

During the past year it has frequently happened that it was found desirable to begin work before the final execution of the project agreement. Under the Rules and Regulations this could not be done, except in cases where the project statement had been approved prior to a certain date. Because of of the unsettled conditions, this was found to work more or less of a hardship, especially on those states whose engineering and office forces had been most seriously depleted by the war. A new amendment, therefore, was made to the Rules and Regulations which it is believed will fully remove this difficulty. Under this amendment, which was approved by the Secretary of Agriculture November 7, work may begin as soon as the plans, specifications, and estimates are found satisfactory and are approved. It is the purpose of the Bureau of Public Roads to obtain approval of the plans, specifications, and estimates by the Secretary of Agriculture as soon as they have been reviewed and found satisfactory to recommend for such approval. The review of the plans and specifications will in all cases be expedited as much as possible and the approval secured from the Secretary with as little delay as possible. After such approval work may proceed on the project, but, of course, no vouchers can be passed for payment until after the formal execution of the project agreement. The approval of the Secretary is necessary for the reason that the Act requires his approval of the plans, specifications, and estimates. It is believed that this new plan will provide a practical and satisfactory working arrangement.

There may have been some disappointment over the stand taken by the Department of Agriculture in regard to cost plus contracts. The position so far taken by the Department is that no part of the per cent. over and above the cost allowed the contractor under such contracts can be paid from the Federal funds, but that payments may be made on the basis of the unit prices in the approved estimate, omitting only the percentage actually paid the contractor as profit. Under this ruling it is clear that only in those cases where 50 per cent. Federal aid is desired will any inconvenience be experienced. The matter is, however, now being reconsidered and it is possible that a more satisfactory interpretation may be arrived at. The place and value of these contracts is well known to the engineer and road builder, but seem to be not so well understood or appreciated by our law makers and law inter-

preters. In fact, there is at the present time a bill pending in Congress to prohibit entirely the making of any form of cost plus contract by the Federal Government.

During the past year comparatively little difficulty has been experienced in regard to the establishment of the post road status of the various projects which have been submitted for approval. In general, the percentages of allowable non-post road mileage prescribed by the Secretary have been found satisfactory and workable. In occasional instances, however, where the non-post road mileage happens to exceed the allowable percentage, there seems still to remain some doubt as to the character of evidence required to establish a reasonable prospect that the road will be used for transportation of the mails after the completion of the improvement. This is especially true where the claim is made on an economic basis. The mere unsupported statement that the improvement will stimulate settlement and thereby bring about conditions which will demand the establishment of a mail route is not sufficient. Such a claim should be substantiated by evidence showing the condition of the land in the vicinity of the road and the extent to which development and settlement has already taken place, together with its availability and suitability for further settlement and development. If a road should pass through barren lands or sand hills it is clear that only limited settlement can be expected, while if it is shown by definite facts that the land is fertile, adapted to settlement, can be purchased at a reasonable price, and is within reach of good markets, at least a reasonable prospect may be deduced therefrom that such settlement may take place. If examples can be given where, in the immediate region, road improvement has led to added settlements and establishment of postal routes, it would be well to include such facts as indirect evidence tending to establish the claim. If a Congressional amendment to the Act could be secured changing the definition of the term "rural post road" so as to allow a more liberal interpretation than that now given, all trouble in regard to the best route status of any project would thus be obviated.

In a great many cases after the final surveys and estimates have been completed it has been found desirable or necessary by the Highway Departments to make considerable alterations in the projects as originally submitted, either in the length or in the proposed type of improvement. In some cases these have been sufficient to change the post route status of the project and in other cases so radical as to entirely change the type of construction which was contemplated when the project statement was approved. In all such cases a clear and concise statement of the reasons for the changes should be made. The Bureau of Public Roads realizes that the abnormal conditions which have existed during the past two years have frequently made such changes not only desirable, but necessary, but it is very probable that in the future such changes will be much less frequent than in the past. The chief difficulty occasioned by such changes has been the delay in securing approval of the plans, specifications and estimates and the execution of the project agreement, due to the neecssity for obtaining additional information to explain and make sufficiently clear the reasons for such changes. The Secretary of Agriculture naturally feels that where the change is sufficient to alter the original project entirely, he is entitled to know the reasons for such change before giving it his approval.

In this same connection delays have occurred, especially in those states where funds are supplied by local communities, from the fact that frequently the final estimates have greatly exceeded the funds originally appropriated or set aside and made available. In such cases the Secretary insists that definite evidence be presented to show that the additional funds will be forthcoming when needed and that the proper authorities concur in the additional expenditure. When final plans, specifications, and estimates on projects of this nature have been sent in unaccompanied by such evidence, there has of necessity been a delay until the additional papers could be secured. The return of more stable conditions will, of course, make it easier for the engineer during the reconnaissance survey to approximate more accurately the actual cost of the project, and the necessity for providing additional funds will occur less frequently.

Suggestions

With the cessation of hostilities and the arrival of the period of transition from war to peace, observations and suggestions as to future activities may with propriety be made. It is the opinion of many people that with the demobilization of our armies and the readjustment in the industrial world which must follow the cessation of practically all lines of war work, there is certain to be, for a time at least, an over supply of labor. If such should be the case, the several state highway departments can perform a great public service by taking the necessary steps to have work proceed on as many delayed road projects as possible, thereby affording work for as much of such labor as can be utilized and helping to prevent any extensive unemployment with its inevitable unrest and suffering.

In road work in general the largest single item is labor. Some conception of the possible extent to which the labor supply may be utilized in road work may be gained from the fact that only a relatively small part of the $30,000,000 of Federal aid appropriated for the fiscal years 1917, 1918 and 1919 have as yet been actually expended. In addition, the apportionment of the $20,000,000 appropriated for the fiscal year 1920 is now in process of issue. While this latter apportionment will not become available for expenditure until July 1, 1919, all preliminary arrangements can and should be made, so that, if necessary or desirable, work may commence immediately after July 1. Thus we see that nearly $50,000,000 of Federal funds, which must be duplicated by at least an equal amount of state funds, making in all about $100,000,000, is or will be available for expenditure. Here, then, is an opportunity to absorb a very considerable portion of any possible labor surplus.

In most of the states the depletion of the engineering forces has made it impossible for the highway departments to prepare in detail any extensive future plans. However, many of these engineers will soon be returning and plans for the future can and should be adequately dealt with. In order that they may be properly prepared to meet the conditions which are sure to arise some states will have to have additional funds appropriated, and in some it may be necessary, or at least desirable, that the powers of the highway departments be enlarged. In this connection, I would most urgently suggest that the respective highway departments, through the proper channels, place these matters before their legislatures so that proper action can be taken without delay. We may feel certain that if any emergency develops it will appear during the coming year, and measures to meet it must be available without delay or they will prove useless.

In planning for future road construction, I wish again to direct your attention to the need and value of main market roads, both from an economic and military standpoint, as demonstrated during the past two years. The tremendous development of truck traffic, motor parcel post routes, the direct distribution of farm products, and the delivery of military supplies, are all dependent on the existence of adequate main roads. I, therefore, commend to your earnest consideration the suggestion that so far as possible and compatible with state laws, the expenditure of the Federal funds should in the future be confined to the improvement of a system of main roads. On the whole this will not necessitate any extensive change in the tentative five-year programs which were adopted before the war, but will require a greater concentra-

tion of expenditure on the more important routes of those programs. In other words, it would seem desirable, in the light of recent developments and experiences, that as many through and inter-communicating main trunk line routes as possible be completed at the earliest possible date. If any decided labor surplus should develop, this accomplishment should be possible within the next few years with the funds now available and with those which will become available within the next 18 months. If no undue labor surplus should develop, the plans will still be of full value and can be carried on as rapidly as may be found practicable.

1921, and $100,000,000 to become available July 1, 1922, in all $425,000,000 to be expended in the same manner and under the same provisions as the Federal Aid funds now available. Such appropriation might be further supplemented by a provision whereby the Postmaster General should set aside at the close of each fiscal year, or at such shorter period as he might determine, 50 per cent. of the net proceeds derived from the operation of motor trucks engaged in carrying parcel post mail on motor truck mail routes. This latter provision would help to coordinate road work with the needs and expansion of the postal service.

VIEWS ON VARIOUS FEDERAL AID ROAD PROJECTS.

Top Row: First two views show concrete road built by County forces in North Carolina in 1918—Concrete Highway Bridge in Virginia. Bottom Row: Three views of Sand Clay Roads in the vicinity of Goldsboro, North Carolina.

The continued operation of the Federal Aid Road Act would no doubt be facilitated if the act were amended in such particulars as are suggested by the results of its operation to date. Such amendments as might be made, however, should be made with a view to disturbing as little as possible that part of the existing machinery of operation which has functioned satisfactorily. It is thought that such changes in the law as appear desirable at this time might be brought about by the following suggested amendments:

Suggested Amendments to the Law

The definition of the term "rural post road," as given in Section 2 of the Act should be changed to permit of more liberal interpretation of what constitutes a "post road." It would seem that this could best be accomplished by changing the word "may" in the third line to "can," so as to make the definition read "That for the purpose of this Act the term 'rural post road' shall be construed to mean any public road over which the United States mails now are or CAN hereafter be transported, * * * *."

There is a limitation imposed by the Act which in my judgment should be removed. It is the provision in paragraph 2 of Section 6, which limits the payment which may be made by the Federal Government to not exceed $10,000 per mile, exclusive of the cost of bridges of more than 20 ft. clear span.

The Federal Aid Road Act makes no appropriation beyond the fiscal year to end June 30, 1921, so that if the work inaugurated thereunder is to be continued thereafter new appropriations will have to be made. Also in order to give due impetus to highway construction work along with the transition to peace conditions, it is believed desirable that a supplementary appropriation be made to become immediately available, in addition to that which is now available from the appropriations under the Federal Aid Road Act. It is my judgment that such supplementary appropriation should consist of $50,000,000 to become immediately available, with $75,000,000 to become available July 1, 1919, $100,000,000 to become available July 1, 1920, $100,000,000 to become available July 1, 1921, and $100,000,000 to become available July 1, 1922, in all $425,000,000 to be expended in the same manner and under the same provisions as the Federal Aid funds now available. Such appropriation might be further supplemented by a provision whereby the Postmaster General should set aside at the close of each fiscal year, or at such shorter period as he might determine, 50 per cent. of the net proceeds derived from the operation of motor trucks engaged in carrying parcel post mail on motor truck mail routes. This latter provision would help to coordinate road work with the needs and expansion of the postal service.

The supplementary appropriations suggested would give a great impetus to highway work, afford employment to labor and stimulate industry, and enable immediate and definite progress to be made in the improvement of a connected system of highways throughout the country.

Snow Removal From New York State Highways

By Edwin Duffey, State Commissioner of Highways, Albany, N. Y.

When the request came to us in January last as the result of the change of routing of the army trucks so that they would use our main line from Buffalo to New York, we undertook through the local authorities to answer the demand. The snow already was deep on the highways because of two heavy storms. The local authorities co-operated, however, in an eager way and considerable assistance was rendered. Nothing could be done, however, to make this long route useful in the fullest way because in a large part of the state the snow and ice was packed on the highways to a depth of 2 ft. or more, said Mr. Duffey in addressing the Highway Traffic Association of the State of New York.

Save the Sleighing

In connection with the transport of the army trucks the question of what should be done for the entire winter was considered. It was generally agreed that what was needed for the government for the transport of its trucks should be responded to, but at the same time the question of saving the sleighing was also discussed. In places where the snow was to a large extent wholly removed—and this happened in several places—there was quick protest from those using the highway in the immediate vicinity, the claim being made that sleighing was destroyed at least after a single warm day.

I speak of this phase because it seems clear to me that this must be carefully considered or snow removal legislation of the right sort will not easily be obtainable. It is my belief

that the problem can be handled in a practical way so that truck traffic can be made possible and feasible and at the same time the roads can be in a condition for sleigh or runner traffic.

Before the legislature adjourned an appropriation of $50,000 was made for defraying the expense of snow handling on the truck routes during this winter. We have had up with the Federal authorities the question of the routes to be used this winter and they have been agreed upon. Third Deputy Commissioner Rice has been designated to take charge of the work and plans deemed at this time to be quite complete have been made so that we expect to be able to keep the truck routes in the condition desired well into the winter. If we should fall short so far as funds are concerned, the legislature will be in session beginning in early January, and further appropriations, if deemed advisable, may be made before it is too late.

Snow Removal Equipment

This phase of the situation was discussed with the committees when the $50,000 appropriation was made. We have arranged for the building of a considerable amount of snow fences. We have purchased snow plows of the type used in Connecticut last winter. They will be operated with trucks now owned by the Highway Department. We shall also have a considerable number of road scrapers which will be operated by horse power. We expect, in fact have arranged, for the co-operation of the townships and counties along the routes so that the necessary machinery, teams, and manpower will be available when needed. The subdivision of our organization provides for the county as a unit and the county superintendent will at all times be in touch with the townships along the route. In short, provisions made last winter for snow removal on the army truck routes have been provided for and we expect that the organization and the arrangements made will result in the keeping of these routes open when and where needed.

Local Choice of Routes

It has been decided that the different localities in the state where snow removal is needed should in a local way meet and consider what routes, if any, are deemed of importance from a snow removal standpoint. That mileage beyond our power to handle might not be suggested, all have been advised to consider the whole question in a conservative way and recommend only the most urgent routes, giving at the same time their reasons for the recommendation.

At meetings the objection on the question of injury to sleighing conditions was several times sharply raised, and the general feeling was that any proposed action on the subject should not destroy sleighing.

While it is an expression of opinion on my part, I feel that I should say that I believe that this important subject must be handled so that sleighing should not be destroyed or nothing will be accomplished because of opposition. I think it is generally known that a large part of the highways in the state are for several months in the winter covered with snow and that the inhabitants are accustomed to travel these highways on runners.

A difficult situation is produced if a portion of a highway which is near market centers becomes bare. The farmer must leave his home, unless he lives on the bare section, on runners, and the moment he strikes the cleared ground he cannot move on. On the other hand, the farmer cannot leave his home on wheels.

I find that quite often that the snow conditions of a large part of New York are not generally known to those interested in snow removal. Conditions in Connecticut for instance, resemble conditions encountered in this state in the neighborhood of New York and Long Island. These conditions are wholly different from those usually obtaining in Central and northern New York.

General Considerations

We have 80,000 miles of public highways and our state is very hilly. Our traffic lines are not centered as is the case with a large part of Connecticut. Sometimes our large markets are long distances apart. For instance Watertown is 75 miles from Syracuse and Jamestown is an equal or greater distance from Buffalo. Binghamton is 90 miles from Syracuse.

There must be some general or central control either that of the state or that of the county. It is our view at the present time that the best method probably will be to make the county the unit and make the county and township pay a considerable portion of the cost, the state contributing thereto in a way similar to the state's contribution to the maintenance of town highways.

The needs of a particular section will be fully and fairly considered—with the local authorities having their full say—as far as what is to be done during the early part of the winter. The cost must in the first instance fall upon the locality because there is no law existing which permits the state to bear any portion of the cost or to have any power over the locality —except the present law of long standing which requires towns to handle their own snow problems at their own expense. Of course the state through the highway department has a certain supervisory authority.

The proper relations of all interests should be maintained and the economic question involved carefully thought out. It seems to me we must meet modern and new conditions in a sensible and progressive way and should also preserve and save that which we have. One of the big questions to meet is the extent of the mileage involved. If this mileage should turn out to be very large, the cost will be correspondingly great. I have sometimes wondered myself how we could handle the question of clearing certain roads and not others. This question would come up usually where the state was contributing a considerable portion of the cost and would also come up if the county at large was to bear a substantial portion of the cost.

This question of selection is a difficult one and unless it can be done without friction trouble would result. In a way the history of the Highway Department in connection with the selection of the construction of certain highways offers a parallel. Our experience is that the question of selection is a most important and delicate one.

Water Works Conservancy

By Arthur A. Reimer, Consulting Engineer, East Orange, New Jersey

We were not prepared for war. We were not prepared for peace. We succeeded in war. We will succeed in peace. The problems looked unsolvable when we realized the magnitude of the task ahead of us on entering the war, but it is indeed true that to arouse this nation fully the task must be stupendous. Now the greater tasks of peace lie before us, greater because the nation is different and mightier than it was before the war, because we have had a national awakening which we believe is destined to be permanent, because we have seen a vision of greater service. This is not the place for an academic discussion of how to meet all the problems, but what is said below in regard to water works is basic in its application to many elements in our new industrial life.

Salvage Everything Possible

Waste has long been the thief of industry, and in no country more than in ours, with its prodigal wealth of natural resources. Human thought and endeavor here have been directed more in the line of achievement than of economy. Even in the keen strife for industrial supremacy during the past twenty years more thought has been given to refinements of processes, standardization, quantity production and allied subjects than to economy of material. Coal, water, power, light,

heat, raw materials, must be used, of course—so use them!" That has been the spirit of the past, but the new conditions will put two other features into the statement so that it will read: Coal, water, power, light, heat, raw materials, must be used, of course, but use them *thoughtfully* and *salvage* everything possible.

Water Waste

Municipal and private water works suffer from their own sins and the sins of their consumers in this matter of waste, and this article is written with the hope that the water purveyors of this country will remove the beam from their own eye so that they may see clearly to pluck out the mote (?) from their consumers' eye. In other words, the water purveyors have a golden opportunity to become leaders in this movement now assuming new importance. There will be no attempt to build much new material into this discussion of certain phases of water works operation and maintenance, but there are some items which can bear almost endless emphasis, and which should be brought to our attention frequently.

In these strenuous days it is easy to get so engrossed in routine matters that we fail to take time occasionally to stand off and get the true perspective of our job, and in consequence we may overlook some important item that really bulks large in the final result, unless our thought is forced to focus on that particular subject. In this latter class is the general subject of waste and its corrective, conservancy.

Conservancy

In a water system there is a wide range for work along conservancy lines, water being only one of the elements included within the reach of the water engineer or superintendent who senses the importance of this subject. The writer's desire in preparing this article is that it will stimulate thought and interest in the general subject, so that it will not be pushed into the background and forgotten in the days of readjustment ahead of us. The coal shortage of the winter of 1917-18 made many uneasy days for water works operators throughout the country and led to some genuine conservancy work in various plants, the lessons of which should be made permanent and followed up in the many other fields included in a water works.

The Watershed—Open Crop Farming and Forestation

For the purposes of this discussion we will start at the initial point of the supply system, the watershed. Many supplies are drawn from or at large or small areas controlled or owned by the water companies or departments. Only a few of these areas are being used efficiently for open-crop farming or forestry, neither of which will pollute the soil, and, through it, the water. This failure constitutes an economic waste. We can make new forest plantations at such low cost today, and the demand for timber is becoming so great, that no city should delay further in this matter. Western timber, timber from right on the Pacific coast, is today finding an open market on the Atlantic seaboard, indicating the need of immediate action toward reforestation in the East. Careful study of the local and distant lumber markets is involved, and the trend of demand to certain kinds of woods, in order to determine the best trees to plant. Existing stands of timber should be examined for mature and defective trees, the former to be cut for the timber market, the latter for cordwood, in order to save coal. Systematic development of old and new growths can be made a paying investment in the vast majority of cases. Careful study of each tract should be made and a definite plan determined on before any work is done, as much damage and loss will probably be produced through hasty, amateurish action, resulting in unjust criticism and possible abandonment of the project.

Drainage of Swamp Areas

Then there are the swamp areas in the water reserve. The extent of attention given to these tracts now, where any is given, is to oil them occaslonally to prevent mosquito breeding. So they lie year after year, supplying the main body of water with its swampy taste, food for algae, and the high color so difficult to remove by ordinary treatment. If these swamps are upland tracts they should be studied for drainage and permanent removal, thereby fitting them for farm use or forestation; if they border the lake, pond or reservoir used as supply storage, the problem may not be so simple, but much may be done to remedy the trouble even in these cases, each area being studied for individual treatment.

Storage Reservoirs

Every water department and company in this land should lend active or moral support to the movement for the development of storage reservoirs along the river systems of the country. Every acre of storage added along these rivers not only increases the permanency of the potable water supply, the irrigation water supply and the power water supply, but does that other highly important thing, decreases the enormous annual losses through floods, a conservancy item equaled in importance by few, if any, in the list. This item of flood control has not been properly placed in our national economy, except by the few engineers who have calculated the true damage done by uncontrolled streams. The loss of life and personal property in the great floods of the Mississippi, Missouri and Ohio systems attracts much attention, yet is soon forgotten by the big mass of people, being remembered only by those directly affected and by those engineers who add each year the new losses to the staggering, accumulated totals.

The unfortunate thing is that few people realize the enormous economic losses produced by these floods. The scouring action of running water is well known and it is easy for any one to see the damage done by it in the uplands, in tearing off the rich, fertile top soil and carrying this costly element out into the swollen streams to mix with the inert clays that have been scoured from the river banks by the millions of tons. A small portion of this valuable mud is finally deposited on the lowland areas, along with the heterogeneous debris of trees, stumps, brush and general wreckage, but the greater part passes on downstream and out into the ocean, an absolute economic loss. The magnitude of the floods in the Mississippi basin overshadows the losses that occur with the same regularity in many other parts of the country, but the proportionate damage is just as great in the smaller valleys as in the large, and is just as important economically. Thus the problem may be considered practically universal, one in which every American is interested, whether he realizes it or not. The value of forested areas on all watersheds in holding back the rainfall run-off, preventing scouring and increasing percolation, is well recognized by engineers, and emphasizes the importance of the forestry work mentioned above.

Pumping Station

The pumping station is, in many cases, a source of great waste, most of which can be eliminated at small cost. A survey of many of these power plants will disclose several, if not all, of the following defects: Improper firing, producing too thick, too thin or "spotty" fires; defective grates, permitting cold air to blow through the firebox; cracks in the boiler settings, allowing cold air to come in over the fire instead of under; careless ash dumping, carrying much good coal through to be wasted on the ash dump; boiler tubes coated with scale and soot, preventing efficient steaming; steam pipes not properly insulated; leaks in steam lines; failure to use exhaust steam for heating purposes; pump "slip" ranging from 10 to 50 percent; and no automatic registering devices for the various functions of the station, nor instruments for taking even occasional records. This list forms a heavy indictment of our water plants, yet we must face the facts as they are.

If a convict derives any comfort from the knowledge that he is not the only one in a striped suit, perhaps we can take

the same kind of comfort in this matter by saying—it is a fact—that other power plants than those for pumping water show the same defects. This is where the writer's hope comes in that the water plants will take the lead at this time in this conservancy movement. These defects are not difficult or expensive to remedy. Many of the plants can be brought up to high efficiency without the aid and advice of a consulting engineer, and in many other cases such outside advice will be limited to small expense.

Leakage

The loss of water through leakage from the main conduit is frequently heavy, especially if this main passes under railroads and streams, or through marshy or quicksand districts, furnishing unstable foundations, where leaks often give no surface evidence that they exist. Of course, meters form the check here. There should be a stroke counter on every pump, and a Venturi meter or pumping station pitometer on the main conduit just outside the pumping station, or at the dam in case of a gravity supply. If there is a distributing or equalizing reservoir along the line of the conduit, the same type of measuring apparatus should be installed on the outlet from the reservoir. The two sets of instruments furnish the means of measuring the leakage along the part of the main from the pumping station, or main reservoir, to the distributing reservoir, allowance being made for fluctuations in reservoir levels.

The writer had the interesting experience, in one case, of finding that apparently more water passed out of the distributing reservoir than was pumped to it from the pumping station. The explanation was that there was practically no leakage in the several miles of conduit, and the possible errors of the two meters happened to show up with opposite signs, the one at the pumping station being negative, that at the reservoir being positive. If serious leakage is discovered in the main conduit, indicated by the meter readings, careful tests may have to be made, or possibly a pitometer survey, in order to locate the break or other defect.

Twenty Percent of Water Lost

The check between the supply point and the consumption by the various users and uses is not a simple one; in fact, the writer knows of no case where any such check has been made with anything like close agreement. Even in fully metered cities, with the methods now in use, the check fails to account for more than about 80 percent of the amount delivered into the main conduit. Here indeed is a field for work. The loss of 20 percent or more of the total water is too serious to allow to continue and the prize of accounting for the difference is worth attaining, for it costs just as much to pump the 20 percent or more that is lost or unaccounted for as any 20 percent or more that is used for good purpose and paid for. It matters not whether this amount is actually wasted through leaks or is used by consumers and not paid for, the effect is the same: the company or department loses the value of that amount of water. Slip of pumps, slip of meters, leaks in mains, services and house plumbing, blow-offs left open after use, and unlawful and unknown connections, all have their bearing on this problem.

Waste Surveys and Meterage

More careful surveys must be inaugurated; meters must be carefully tested at proper intervals to establish the true curve of delicacy and accuracy of registration as affected by length of time in service; house-to-house inspections must be made at intervals, even in metered cities, to detect leaks not registered by the meters, or that affect the meter only slightly; compound meters must be used on all services from 1½-in. diameter up; every connection must be metered, including fire lines, public uses in public buildings and parks, automatic sewer flushing, and public drinking fountains; more careful records must be kept of water used in street sprinkling and flushing, fire fighting, hydrant and dead-end flushing, sewer flushing from hydrants, building construction and general construction work (where not metered), road building, loss of water through breaks in mains, and incidental uses not metered. With these data properly prepared we will then know where the real loss occurs and can decide on the methods to be used in ending it. The work outlined above need not cost much, though it looks formidable. The whole list of items can be handled economically with proper organization, and the data obtained will be of far greater value than any cost involved in collecting them.

Combating Water Waste

Having gathered the necessary data to account for the water delivered into the main conduit, or as many data as the present conditions permit, the waste of water should be attacked vigorously. Two plans must be followed, *action* and *education*. Action should be taken in all cases involving the company or public elements. Education should be started in all matters affecting the private users.

A few suggestive points on the subject of action are all space permits here. Constant-flow "bubblers" or open drinking faucets waste about 99 percent of the water passing through them, being allowed to run all night as well as all day. Public fountains are allowed to play all night; the majority of so-called fountains have no beauty whatever, and the waste of water should be stopped at once in all such, but where there is genuine beauty in a fountain, the use of water in such during daylight and evening hours is a legitimate charge to the esthetic and artistic features of the civic life, but should be stopped during the night hours. Street sprinkling during rains (a condition that exists more frequently than we like to admit) is not only waste, but shows poor control and organization, basic faults that work much damage to any company or department. Automatic flush fixtures in public buildings and other places not occupied or used except during the week days, are allowed to act all through the night hours and on Sundays and holidays, thereby wasting much water. Automatic flush tanks for sewers are allowed to become defective, so that instead of using a maximum of a few hundred gallons per day per tank, the use (waste) reaches into many thousands of gallons per day; in a recent survey the writer found nearly 90 percent of such tanks defective or inoperative, wasting water into the sewers with no flushing action whatever. Other items will readily suggest themselves with a little thought, but the above indicate the type of losses that may be found and easily stopped.

Cost of Water Waste

In connection with the above, two points deserve emphasis. First, wasted water not only costs as much to supply as used water, but takes up just as much room in the mains, unit for unit. Heavy bond issues are required to meet the expense of larger and larger mains in order to keep up proper fire protection and supply the public and private use—and waste. In cases where the supply is closely limited, waste hastens the day when a new supply at greater distance must be developed, at high cost. Elimination of waste produces the same effect as increasing the size of mains, but costs much less than larger mains throughout the system. Also, elimination of waste lengthens the life of a given capacity supply, postponing higher interest charges on bonds and increased operating costs. Second, water must be disposed of after having been used, and sewers and sewage disposal plants must be of sufficient capacity to care for all sewage delivered to them—including wasted water. Thus wasted water compounds its evil by requiring both larger water mains and larger sewers and disposal works.

Education to Prevent Waste

Education of the private user is a long, hard task, but the rewards of success in this matter are so great that no water purveyor should consider his work in any sense complete unless he is constantly pounding facts into his public by talking, by pictures, by charts, by physical illustrations, by printed reports, memoranda, circulars and newspapers. We all know

how difficult is the fight for meters, yet those of us who go back 15 or 20 years in our experience in this line know that education has been the great, intangible force that has produced the present-day result, with every year seeing the list of "100 percent metered" municipalities lengthened. Educate, educate, educate—and then do it some more! And now we are getting close to the point where we can consider that mote (?) in our consumer's eye. The strongest feature in our educational work will be the fact that we have corrected the defects in that part of the system under our immediate control, or at least are earnestly working toward that end.

For 100 Percent Meterage

The elements in this part of the program of conservancy affecting the private user are practically the same as those involved in that part which dealt with the public use, and again are to be considered suggestive only and not intended as being in any sense complete. The adoption of the meter system is basic and should be pressed at all times till the 100 percent goal is attained—and maintained. The arguments for metering are old grist, well known to all water works men, and will not be reground here. It is beyond the meter that our field lies now. The consumer should be warned against and instructed how to avoid waste of water through the use of constant-flow and automatic fixtures during periods of non-occupancy of the buildings.

Possibly a few persons, from both private and municipal plants, will not agree with this suggestion, on the ground that they are in business to sell water, but the old plan of considering accumulation of wealth the proof of success has been recast in the fierce heat of change produced by the war, and today and in the future the new plan will involve the production of wealth as the foundation of true business success, and *wealth cannot be produced through waste.*

Abolish Wasteful Fixtures and Methods

Most of the private companies and municipalities have adopted the policy of advising their customers against the use of wasteful fixtures and methods. That is as it should be, for that is the very essence of our work of education. Teach our patrons to *use* water, encourage them to *use* it for all economical purposes, personal and industrial, but teach them not to *waste* it. Teach the housekeeper to watch the fixtures for leaks, the kitchen and laundry uses for waste. Teach all consumers to read the meter and how to make a simple test for accuracy of registration and proper condition of fixtures. Teach the large user to equip with proper fixtures, to adopt the plan of systematic and frequent inspection of all fixtures and uses, and immediate repair of defects. Teach the industrial user all the above items, and encourage him to have occasional independent surveys made to check his own inspectors and suggest improvements as to the use of "process water" and the reclamation of a large proportion of such water.

Proper Accounting Systems

The writer here wishes to make a plea for proper accounting adjustments as an integral part of conservancy work by the water companies or departments. Reduction of waste of water will produce material financial savings and the water purveyors and water users should receive credit for the work done and encouragement for the continuance of such work. Most of the private companies receive pay for water supplied for public use, either as direct cash payments or through abatements of taxes, or the franchise may require the company to furnish such water free. On the other hand, few municipal departments receive payment for public water uses or services rendered the public. Such a system is false. The company or department should be paid for all water supplied the municipality and all services rendered, including fire protection (hydrants), public buildings, schools, hospitals, parks, swimming pools and other features usually forced into the "free list" by municipal bodies.

The various state public utilities commissions are correcting this to some extent by better accounting systems, but this is not an adequate or proper recompense, as this only permits of book entries to show what really should exist with actual cash transactions as the rule of settlement. The municipal departments fare worse in this matter than the private companies, the claim being made that a municipal department should not charge its owner, the municipality, for water and services. Such a claim does not bear analysis. It would be all right if a municipality were only one simple unit, but a municipality is complex, an aggregation of departments, each performing a definite function, each allowed certain funds with which to carry on its activities, the amount for any given department being supposed to represent the true cost of operating that department for the year.

To put into a tax budget an item of $300,000 for road maintenance, this amount including no allowance for water used in this work, when such water probably costs not less than $15,000, is making a travesty of municipal accounts. A school appropriation of $3,000,000 that does not include the charge for water supplied the schools, probably amounting to nearly $50,000, is clearly a deception. In similar manner, a water department that occupies municipal buildings and land and does not pay rent for all such, is working on a false basis of operation.

Fictitious or theoretical book accounts do not pay coal bills or labor charges, buy materials or meet interest on bond issues. Hard cash in the hands of the water department forms the only basis on which operating costs can be met and rates established. Mercantile houses handling several lines of goods keep the closest watch of the cost and income for each separate line. Manufacturers carry out the same principle in each department in order to determine true unit costs and selling prices. There is no sound reason why a municipality should pay a private company an annual hydrant rental, and then refuse to pay that same rental to its municipal water department when the private company passes into the control of the municipality through purchase.

The water users' money is now expended for operating costs of all kinds, including cost of water wasted in the various public functions. If, in addition to the regular charges, the water users' money is expended in conservancy work and thereby the public waste of water is stopped, so that with proper accounting adjustments in force the annual payments for public water would be materially lowered, the other departments thus benefited should certainly assume the actual cost of the water delivered for their use. If the establishment of business methods of accounting and cash transactions would lead to lower water rates, it is but simple justice that such methods should be introduced at once, so that the water users may receive this benefit at the earliest possible date. This question is a straight business matter and should be settled strictly on a business basis, or our municipally owned utilities will be in bad odor continually.

Conservancy Not Expensive

In closing, I wish to emphasize again that conservancy work is not expensive. Conservancy engineering supplies the means and methods of accomplishing the desired results, but much of this work can be done through the use of the natural gumption inherent in the average American. The financial returns on any investment in this class of work are very large; the moral returns to the individual and the community cannot be measured in financial units, but will be expressed in a keener civic conscience and a spirit of mutual helpfulness that must eventually raise to a higher level the entire community life. The work does not stop with the saving of water. Having initiated conservancy work in connection with the water, coal, land and other items in our own system and control, we can properly urge and aid in the conserving of raw materials in the industries, and the saving of food, light, heat, power and other elements vital to the every-day life of all

parts of the community, the result being that living costs will be reduced and the habit of thrift become more widespread, strengthening the nation at a point where reinforcement is needed at this critical period of our nation's life. Thus will our policy prove its value, for the policy is universal in application. Any other policy spells economic waste, and economic waste spells ultimate economic ruin—for the individual, the industry, the nation.

Performance of New Jersey Highways Under Heavy Motor Truck Traffic

By W. G. Thompson, State Highway Engineer, Trenton, New Jersey

The entry of our country into the European war and the railroad congestion of last winter subjected our roads to the supreme test, under which many of them failed most lamentably, although every effort was made to keep the through routes passable. Most of our failures were due to insufficient and unstable foundation, and inadequate drainage, which lack of drainage in conjunction with the expansive effect of frost, in many places simply turned the roads upside down. Added to this, the incessant passage of heavily loaded trucks turned the saturated sub-base into a quaking mire. A consequence of this was a loosening of the stones in the underside of the pavement, resulting in such a disintegration of the structure that in many cases the rear wheels broke through the crust and it was necessary to jack up the vehicle and place planks under the wheels to extricate it.

Light Pavement Base Broken Down

These conditions applied not only to the water bound and bituminous macadam pavements, but to the asphaltic concrete pavements laid on macadam or broken stone foundations as well. We had many cases where expensive bituminous pavements laid on macadam bases of insufficient thickness, and inadequately drained, blew up or broke through under the heavy loads, and constant traffic. When I say constant traffic, I mean a continuous procession of trucks in both directions, besides the thousands of passenger and lighter cars. As an instance of the density of passenger car traffic to and through New Jersey coast resorts, a census was taken on a Sunday afternoon last summer at a bridge where all traffic along the shore must converge to cross a stream. Between 2:30 and 6:30 p. m., more than 5,000 cars passed a given point. It is easily realized that the problem of providing improvements adequate to sustain such a traffic is a serious one.

Failure to Remove Snow Was Costly

I believe I am safe in saying that highways in the East suffered greater damage during 1917 and 1918 than during the preceding three years. Neglect or inability to remove snow caused the ruin of miles of eastern pavements last winter. Heavy trucks wallowed through and finally broke a path, which eventually wore down to the pavement. Other vehicles followed the same track, which except for certain stretches was used for several weeks; thus the entire traffic was confined to a few inches of width in each wheel track instead of being equally distributed over the entire surface. This naturally resulted in deep ruts which were difficult, and in many cases impossible to repair properly.

Destructive Skid Chains

Another destructive factor was the heavy skid chain used by the trucks. Many of these had links ¼-in. thick and were so spaced that there were but three wraps to the wheel; therefore, instead of action resulting from the lighter chains on passenger cars where the chains are about 6 ins. apart, there would be the impact and grind of these heavy chains for each 1 3 revolution of the wheel. No pavement could withstand such a pounding and grinding. The man who will invent a non-skid device for heavy trucks which will reduce the destructive effect of the present chains will earn the undying gratitude of highway officials. I believe it will be necessary to forbid the use of such heavy chains, as it is impossible to build pavements to withstand their action. Those of you who manufacture trucks should seriously study this subject in an endeavor to minimize a deterioration which, if not lessened in some way, will militate against the use of such heavy units. This should not be taken as a brief against the widespread use of motor trucks, as I believe in the future of the motor truck, and that it will be an important factor in reducing the cost of living, particularly when roads suitable for trucks the year round are built into every farming community in this country. Mr. Hoover is responsible for the statement that 60% of the farm produce of this country perished during the past summer because it could not be gotten to market; and why could it not be gotten to market? Because there were not good roads leading from the cities to the farms, or rather there were not roads capable of carrying trucks which would make a 100-mile haul for perisbable produce profitable. I say 100 miles because we have farmers in New Jersey who make trips of 80 miles daily, or every other day, to the New York market with 5-ton truck loads of fruit and vegetables.

Motor Transportation Lowers Cost of Living

I can imagine nothing more outrageous than paying 10 cts. for an apple in New York, Philadelphia, Washington, or Seattle. Each of these cities is less than 50 miles from fine apple orchards, yet the hauling of this fruit over indifferent roads to the freight station, loading it into cars, unloading it in the city, trucking to the warehouse or commission dealers, reselling by them and more trucking to the retailers, all contribute to the cost. An extensive system of uniformly good roads into all the rural districts would enable the building of storage depots right at the orchard, whence the organization handling the produce could truck directly to the stores of its retail dealers, with a consequent saving of time, money and power, and enable the delivery of produce which has not deteriorated through excessive handling. The possibilities for the future of highway transportation are unlimited, but the possibilities of the highways are limited, that is, there must be a limit to the weight, tire width, and speed of vehicles using the highways, as the destruction of the past year bears evidence. If an arbitrary limit as to weight is not adopted, the race between the trucks and the highways will be a merry-go-round with the trucks always a little ahead.

New Jersey Roads Designed For Truck Traffic

Our effort in New Jersey to lower maintenance costs and provide foundations to carry the loads resulted in the laying of concrete pavements 8 ins. thick at the sides and 10½ ins. thick at the center, on our main through routes. It remains to be seen whether this thickness will suffice, as its adoption was purely arbitrary, and with the hope that it would prove a solution of our difficulty.

Maintenance Difficulties

As an indication of the difficulties encountered in maintaining pavements during the past year, and of the increase in traffic volume, our traffic census on one main route shows an increase of more than 300% over that of early months of 1917. Mr. Breed of New York reports an increase of truck tonnage varying from 50 to 400% and an average increase of 150% over that of 1916. Similar increases are noted in Pennsylvania, Delaware, Maryland, and the seaboard states of New England. It should be understood that these heavy increases are on the main or intra-state routes, especially in Connecticut, New York, New Jersey and Pennsylvania.

It is easy to imagine the difficulty of maintaining or rebuilding main highways under such traffic conditions. In localities where suitable detours were not available traffic was carried on the shoulders or on improvised passageways over the roads where repairs were in progress, though at additional expense.

Where detours were available, they were generally secondary or township roads, built for the ordinary farm traffic, and naturally went to pieces under the pounding of heavily loaded trucks. This damage to secondary roads amounted to hundreds of thousands of dollars, and should be borne in mind by shippers and truck owners generally. Unusual efforts were uncomplainingly made to keep the trucks moving as a patriotic duty during the war period. Mr. Edward R. Viets, of the Service Recorder Company of Cleveland, states that motor trucks increased from 60,000 in 1912, to 600,000 in 1918. These 600,000 are only a nucleus around which will be built a real fleet of trucks. The highway authorities of this country are awakening to their responsibilities, and will build, as rapidly as possible, pavements capable of sustaining the traffic. It must be realized, however, by all truck users, that up to the present there has been no attempt to co-ordinate, so to speak, the needs of truck users and manufacturers with the means at the command of highways officials. As a consequence motor vehicle development has far outstripped highway ability to carry it. A shipper in Newark telephoned me one day last winter saying two of his trucks en route to Philadelphia had broken through the road and were stuck fast. He wanted to know if he could get redress from the state for the expense and lost time, which question was about as reasonable as that a ship owner should ask the U. S. Government to reimburse him for the loss of his ship on an uncharted rock within the territorial waters of the United States. This was an extreme case, but as he was quite serious, it is cited to show the attitude of some owners toward the highways and communities responsible for them.

Great Highway Development

In closing, the point I would emphasize is that this country is on the eve of a tremendous highway development, as is evidenced by the enormous sums recently voted by a number of states for highway construction. The Federal Government is awakening from a long somnolent period to a realization that highways are primarily and exceedingly important to the nation's welfare and economic development, and will undoubtedly give substantial aid to the states for new construction. The tremendous needs of the future are being visualized by highway authorities and sincere, earnest efforts are being made to meet these needs in a broad, comprehensive manner. I bespeak for the highway officials the sympathetic co-operation of motor vehicle manufacturers and users to the end that future design shall minimize to the greatest extent possible the damage done by narrow tires, inadequate springs, and the present anti-skid devices.

Notes on Chlorine Treatment of London, England, Water Supply

This year, said Dr. A. C. Houston, Director of Water Examination, Metropolitan Water Board, London, in his report, a cautious opinion must be expressed, not of the efficacy of chlorine as a germicidal agent, but of the difficulties still to be overcome of adding this reagent to water in the proper dose. With the particular apparatus used, quite successful results were obtained during the warm weather, but when the air and water temperatures fell below a certain point, troubles were not far to seek. So far as the instrument was concerned, these difficulties were largely overcome by artificially heating the temporary building in which the apparatus was "housed." Yet this procedure availed nothing as regards that part of the instrument which lay outside the building and was indeed immersed in the water. It is now evident, as the result of practical experience during the cold weather, that either the gas must be added as a solution to the water to be sterilized, or else some improved form of porous diffuser must be discovered. The matter is still under active investigation.

The dose has varied according to circumstances, but was usually 0.5 in 1 million (1 in 2 millions), in terms of available chlorine. With bleaching powder (chloride of lime) of 33 per cent. strength this equals 15 lb. per 1 million gallons. Considerable success, however, has also been obtained with smaller doses, 0.33 in 1 million (1 in 3 millions), or 10 lbs. of material per million gallons. On the whole, the latest results point to a probable reduction rather than an increase in the average dose. As regards bacteriological results, all that is now aimed at is to produce at least as good a result by chlorination of raw river water, as if the river water had been stored in the Staines reservoirs instead of being chlorinated. The Staines stored water 10 cc. B. coli standard is 60 per cent. "negatives" (40 per cent. "positives"). That is, if 100 cc. cultures are made of Staines stored water, 60 of them, on the average, contain no B. coli, and 40 of them contain this microbe. Taking a period embracing the bad winter months, namely, from October, 1917, to the end of March, 1918, the average chlorinated raw river water result works out at 83 per cent. "negatives" and 17 per cent. "positives," figures which show that better results, as judged by the B. coli test, can be obtained by chlorination than by storage. Despite the magnitude of the treatment (70 to 80 million gallons treated daily), no complaints have been received as regards taste.

Super-Chlorination and De-Chlorination

The two great factors which militate against successful chlorination are extreme cold and short contact. Separately, and still more in conjunction, they tend to prevent sterilization, or if sterilization takes place owing to a super-dose, the water is apt to have a chlorinous taste and to contain active chlorine. By a super-dose is meant a dose in excess of what is actually required under more favorable working conditions. It is always best to provide for so prolonged a contact that however cold the water may be, the active chlorine will have disappeared and the water at the same time have been sterilized. In practice, however, for one reason or another, this may be impossible, and in these cases, especially during very cold weather, super-chlorination and de-chlorination may be of advantage. There is another curious circumstance bearing on the question. It has sometimes been observed in the laboratory that when working with minute doses of chlorine, too slight to produce the familiar chlorinous taste, a slight "iodoform-like" taste develops. This occurs sometimes after a water has been de-chlorinated, at other times it is noticeable only before de-chlorination, yet again it may occur both before and after de-chlorination. On the other hand, no taste, unless perhaps the original taste, has ever been observed after gross chlorination and de-chlorination. Hence in certain cases there may, so far as taste is concerned, be an advantage in heavily chlorinating a water and then de-chlorinating it.

On the whole, speaking of the samples neutralized with SO_2, neither temperature nor time appeared to be dominating factors as regards questions of taste.

Next in respect of dose, the amounts (in terms of available chlorine) were as follows: 1 in 15,625, 31,250, 62,500, 125,000, 250,000, 500,000 and 1,000,000, respectively.

The outstanding feature was that with the stronger doses (far greater than would ever be required in practice), despite the extremely noticeable and practically unbearable chlorinous taste of the non-neutralized samples, the ones neutralized with SO_2 were completely free from any taste. Indeed, the slight earthy flat taste of the river water often noticed appeared to be removed or disguised, not infrequently, by super-chlorination and SO_2 treatment. Apart from the cost of materials and the circumstance that the substances (Cl. and SO_2) are not separately innocuous in other than minute doses, the indication is that a combined (in sequence) super-chlorination and SO_2 treatment may be actually advantageous from the point of view both of taste and sterilization. When, however, the case is regarded from the economic aspect and in relation to

the undesirability of using in other than infinitesimal doses substances which apart are not, in the uncombined form, natural ingredients of water, the matter assumes a different complexion. Unfortunately, it is just when the minor doses come to be considered that many of the difficulties arise. Sometimes with, sometimes without SO_2 de-chlorination, but quite as often as without, taste results are obtained, which led to nebulous conclusions.

Some Financial, Agricultural and Engineering Aspects of Irrigation

By Charles Kirby Fox, Consulting and Contracting Engineer, Pomona, Calif.

Irrigation, the artificial watering of crops, was practiced extensively by the civilized ancients both in the old and new worlds. In the United States it is probable that the first extensive irrigation systems outside of the Indian and Spanish systems, were started by the Mormons in Utah, beginning about 1848. The growth is shown by the following tabulation taken from the U. S. Census for 11 western states:

Date	Acreage	Cost per acre
1889	3,631,381	$ 8.00
1899	7,518,528	8.85
1909	13,738,485	15.92

Acreage projects were capable of irrigating in 1909—19,534,697.

Besides this there are some irrigated lands in the states farther east. In the 1909 Census returns there are given figures for the crop acreage and returns for 15 states. The totals are 7,609,269 acres divided as follows:

	Acres	Percentage Acreage	Crop Value 1909	Per cent. crop value	Returns per acre
Cereals	1,655,856	23.6	$33,840,285	20.2	$20.50
Other grain and seeds	69,438	1.00	1,730,602	1.00	24.80
Hay and forage	4,576,425	65.3	74,373,411	44.1	16.30
Sugar beets and potatoes	345,253	4.92	20,774,708	12.2	59.70
Fruits, etc.	362,297	5.16	37,796,363	22.50	105.00

Other Statistics

The projects may be further classified as to the class of projects, namely: Individual and partnership (45.5%), cooperative (33.8%), commercial (10.6%), districts (3.8%), U. S. Reclamation Service (2.9%), Carey Act projects (2.1%), and U. S. Indian Service (1.3%), and further as to the source of water supply, namely, gravity streams (89%), pumped water (3.35%), springs (1.4%), etc.

In 1909 there were 6,812 reservoirs with a capacity of 12,581,129 acre feet. Bulletin No. 1, Progress Report of Co-operative Irrigation investigations in California, 1912-14, Adams, page 25, says, "there were 9,297 pumping plants in California, according to the Census of 1910, (1909) and at the close of the 1914 season they estimated there were 24,589 pumping plants.

In 1913 I had occasion to make an investigation relating to the status of irrigation. As nearly as I could determine construction work on large irrigation projects had almost stopped but the actual settlement and development of land which had the ditches already constructed was proceeding at a very rapid rate, and since the war started it has been greatly accelerated. Many estimates have been made of the total amount of land which it will be possible ultimately to irrigate in the western United States. The conservative estimates usually are around 50,000,000 acres.

Unirrigated Lands

The unirrigated land in the arid regions is practically valueless, not on account of the character of the soil, but because of the absence of the all important factor, the life-giving substance, sufficient moisture. Land which cannot find takers at the land office price of $1.25 per acre will immediately jump to five or ten times that price on the slightest pretense that irrigation will be provided. Ordinary irrigated land suitable for the various field crops, sells for $100 to $200 per acre, and where permanently adapted for intensive farming of fruits, seeds and truck, may bring $2,000 to $3,000 per acre.

The cost, difficulties and time required to bring the land under cultivation have usually been greatly underestimated. It is also true that the first year or two on an irrigated farm is very trying for most farmers, but will not compare with the hardships and privations of the early pioneers. It has been truly said many times that there is more progress, such as roads, railroads, schools, and telephones during 5 or 6 years in an irrigation district than in an unirrigated district in 30 to 50 years.

Financing

To buy the improvements, such as buildings, live stock, and tools for even a small farm, say, 80 acres, will cost several thousand dollars. Then comes the cost of living, clearing, leveling and putting in crops, which will often bring this up to around $5,000 before a dollar's worth of return can be expected. Often farmers with small capital will take several years to bring a farm under cultivation. Rapid colonization by experienced farmers of sufficient means is important. It has been suggested, with a view to facilitate and hasten settlement, that the water organization arrange to clear and level the land, and perhaps erect the necessary buildings, etc., which they could do more efficiently than the individual settlers. I think the repayments on new developments should not start until the rancher has a chance to get on his feet.

To show the advantage of rapid development we will consider a fully financed project costing, say $100 per acre, which will be brought under complete cultivation in about two years. The interest at 6% will amount to $12. Now take the same project with the old style irrigation development costing $50 per acre and taking 10 years to bring under cultivation and the buildings, grading, etc., costing $50, taking 5 years to bring under cultivation. In this case the interest at 6% will amount to $45, and it is very probable the project will default on its interest.

It is absolutely necessary that the lands should be capable of producing valuable crops; that the locality be climatically and geographically favorable; and that satisfactory market and transportation facilities exist or be provided. The land should be so situated that an economical distribution system can be constructed.

Classes of Land

As a general rule the lands of the so-called arid regions are rich in the so-called earthy constituents of plant life, but occasionally contain an excess of alkali. Usually the lands are deficient in humus and nitrates, which can be remedied with leguminous crops. It is my practice when reporting on irrigation projects to classify the lands into three grades; first, absolutely first class land; second, lands with various minor defects; third, lands which are practically valueless for irrigation farming under present conditions. Land which is at present irrigated and probably will be irrigated from other sources is also classified under a subheading of the third class and eliminated from further discussion.

If the water rights and lands belong to the same company, I estimate on selling practically all of the first and second class lands, but if the water rights and lands are owned by separate and distinct parties, for instance, the water-rights by an irrigation company and the lands by small private holders, I estimate only on selling and receiving payment for 75 to 90% of the first and second class lands depending upon local conditions.

Climatic conditions and length of growing season are very important. Where they are usually favorable and the country is highly developed the price of land is usually very high.

Transportation

Transportation is an important factor and is frequently

overlooked by land seekers. In the west, freight rates on the main trunk lines frequently average around 1½ cents per ton mile; farther in the interior the rates are higher, and on branch lines average around 3 to 4 cts. per ton mile, while on narrow gauge railroad lines they frequently average around 7 cts. per ton mile. Wagon hauling usually costs 20 to 30 cts. per ton mile and auto truck hauling depends upon local conditions and is considerably cheaper. Water transportation is very cheap. The transportation should be considered in relation to the class of the products, the ranchers in the back country usually pay a larger return on the investment due to the lower values than the close-in ranchers.

Water Supply

The available supply of water is probably the greatest single factor involved, and will limit irrigation development. The U. S. government maintains a water resources branch of the Geological Survey which has made measurements of the runoff for a varying period of years for the most important streams in the country. These records are usually reliable and it is to be regretted that they are not more extensive and do not cover periods of longer duration. Runoff is usually measured in acre-feet, that is the amount of water required to cover one acre, one foot deep, which is equivalent to 43,560 cu. ft., or 325,850 gals, or 1,360 tons. A cubic foot of water per second is ordinarily called a second foot. A cubic foot of water is equal to 7.48 gals. or 62.5 lbs. A second foot of water flowing 12 hours is equal to approximately one acre foot.

The amount of water required for crop maturing varies with the human factor, the soil, subsoil, etc., crops, climatic conditions, value of water, and many other conditions, usually being from 1 to 5 acre feet per acre per annum. In addition to this it is necessary to add a sufficient allowance for seepage and evaporation in the canals, laterals and reservoir. Unfortunately this may amount to as much water as is used on the lands.

Duty of Water

Some time ago, in making a report on the duty of water I had occasion to collect the results of 258 serial (1018 single) experiments from the agricultural reports published in the Western States. These results were analyzed and plotted opposite yields and amounts of water used to produce maximum crops in each series for the different crops, for elevations, soils, total monthly temperatures for the growing seasons above 50 degrees F., computed evaporation, etc. The other results of the serial were plotted so as to show the percentage of the yield obtained as compared to the percentage of water used to obtain the maximum yield. The maximum yield and the amount of water used to produce this yield were each considered as equal to 100%. These last results are very interesting, as they show a reasonably close approximation to a curve which shows 1/3 the water which would produce a maximum yield under given conditions that ½ the maximum yield could be expected, ½ the water would produce a ¾ yield, 2/3 the water would produce a 90% yield. This seemed to hold true for all soils and field crops; on medium and retentive soils, as loams and clays, one and one half times the water would only produce a 90% yield, and twice the water would only give a 2/3 yield. On porous soils the yield did not seem to decrease greatly, but in each case undoubtedly a large percentage of the excess water goes to water log the land or the lower lying land.

There is great need of a more accurate way to determine the probable water requirements of soils and the probable water absorption of canals, etc. I would suggest driving a small tube, say a King's Soil Sampler, to solid ground, filling it with water and noting the rate of absorption in a given time. These results when compared with an extensive series of experiments should give results which would give fairly dependable and easily applied values when interpreted in the field.

The legal status and titles on irrigated lands are fully as important as sufficient available quantities of water. The riparian or common English law has been rightly rejected in most of the arid states in toto, and doubtless will be in the others soon. The status of irrigation law was formerly uncertain and litigation expensive, but now most states have a state engineer or water commission to look after irrigation matters. This has greatly strengthened titles and lessened litigation.

Irrigation engineering is now on a substantial basis. It is now customary and usual to take sufficient time to make detailed studies of water and storage available, various structures and canals, their location, alternate designs, and comparative estimates, with the result that accurate, complete estimates on dependable plants are available before construction is started. The legal and financial status is usually similarly investigated.

Cost

When irrigation development started, $5 per acre was considered to be the limit of cost. By 1900 it had risen to $10 to $15 per acre and now $25 to $75 per acre is not considered prohibitory if the other conditions are right. These figures relate to the actual construction cost, while the selling price is usually two or three times as much. Maintenance charges usually average around $1 per acre per annum. Before the construction starts other greater or lesser expenditures are, promotion, obtaining water rights, surveys, designs, estimates, reports and legal fee. Then comes the actual construction, cost of selling water-rights, discount, and interest on bonds, general and overhead charges, and development costs. Those so-called and often unexpected outside charges often amount to as much as the construction cost, and seldom less than 50% thereof, and do not include buying and preparing the land which is included in the project. I believe the principal trouble with irrigation projects in the past has been that returns were expected too soon and that not enough care was exercised in obtaining experienced settlers with sufficient means to make their land immediately productive.

I am very optimistic as to the future of irrigation development as we are at the close of a successful war, which will greatly strengthen our national character. Many returning soldiers will demand homes in the open and new developments are practically the only available supply. The country is richer now than ever before and more thrifty, a large number of people have been educated to buy bonds; there will be a large market for most of the agricultural products at remunerative prices for many years and finally investments under our own flag are safer and better protected and understood than those under foreign flags.

Day Labor, Force Account Work and Bonuses on Highway Construction

By Charles M. Upham, Chief Engineer, State Highway Department, Dover, Del.

The question of the economic use of "day labor" in highway construction is an old one, and we have records of where this same question was under discussion at least a century ago. In looking into this subject I find that with some officials in certain sections of the country, the method of doing work by day labor is very popular, but compiling the opinions of a great number of highway engineers, I find that the day labor system has become unpopular, and has the name of being costly and expensive and is without any of the advantages claimed for the contract system, said Mr. Upham in addressing the American Association of State Highway Officials at the recent annual convention in Chicago.

The abnormal times that we have just passed through have compelled us to solve many problems. The "day labor system" is one of the unsolved problems, though its name is old. Dur-

ing the last two years we have seen how in many instances the day labor system has come to the rescue in emergencies, and in only a few instances has the work been carried on at abnormal cost. In many instances the reasons for high costs could undoubtedly be traced to other causes than the fundamental principles of the day labor system.

Both Methods Are Good in Theory

In localities where the supervision of the day labor system has been efficient and the organization permanent, this system has produced, and is still producing, good results in construction at reasonable costs; costs that often are lower than those obtained by the contract system. Advocates of both the day labor and contract system state that, properly controlled, their system produces the better work. With proper supervision, inspection and specifications, the same results can be obtained either way and so the advantages can be compared merely by costs. By theoretical analysis it can be shown how the "day labor" system is not as costly as the contract system, for it does not include the contractor's profits, nor the percentage that is included in the proposal for contingencies.

Overhead Charges

State officials do not desire contractors to do work without profit, nor do they want the uncertainty in their plans and specifications that make the contractor's proposal a gamble. It is accepted by all that the contractor should be paid the cost of his work plus a reasonable profit. In contract work there is generally figured a fair profit and also a percentage for contingencies that do or do not happen. These percentages are in addition to the actual cost of the work which in itself includes the pay for capable foremen, efficient supervision and generally an allowance for the contractor's salary, provided this is not included in the percentage that is added to cover the profits. In other words, the contractor has provided for payment of all expenditures, plus a reasonable profit and an allowance for contingencies; if these contingencies happen the contractor should receive a payment covering them, but if they do not happen, it simply makes a gamble out of the proposal, with the contractor the winner.

The day labor system on the other hand does not include either of these charges of profit or contingencies, but it is the resulting expenditure of the actual cost of the work. Why is it then that "day labor" has not become universally adopted, and why is it that the day labor system is looked upon with suspicion and turned down by engineers wherever there is a possibility of doing work by contract system?

Day Labor System Not Satisfactory in Practice

Many cities, towns and states began their public work by day labor. After a short period we find that in nearly every instance these cities, towns and states have adopted the contract system to protect themselves, and they now get their work done at more reasonable costs.

Contract System More Economical Than Day Labor

That the fear of high costs resulting from the day labor system existed in earlier days is shown by the fact that early in 1800 we find engineers advocating the abolishment of day labor. It is said that Telford estimated the cost of work produced by the day labor system was 50% higher than the contract system. A railroad engineer informs me that he was somewhat surprised that the cost of day labor construction was from 25 to 100% higher than contract work. It is said that in 1909, Metcalf & Eddy went into the comparison of costs of "day labor" and contract work, and in a report to the Boston Finance Commission the result was in favor of contract work. In a few other instances, however, the results show that the work done by day labor is cheaper than that done by contract, but these cases are in the minority. From these statements it seems that the results point in favor of the contract system for securing good work at reasonable cost.

Before condemning the day labor system, however, a comparison of the development of each is interesting.

The First Public Works Contracts

Probably the first so-called contracts were contracts for day labor. One instance is shown by a contract covering the digging of a canal in one of the eastern states, in which it is stated that the contractor should furnish a certain number of men with satisfactory picks and sufficient shovelers to shovel the dirt picked by the first men, and sufficient wheelers to wheel the dirt shoveled. While this was a contract, it was a contract for day labor. The output in general was controlled by the number of men employed, but the amount of work the men did depended to a certain extent on the foreman or supervision. The next step was a closer control of the amount of work completed rather than the number of men working.

This was development in the contract system and made this system become popular among contractors, for by securing the best supervision and using certain ingenious devices, short cuts in doing work by the contract system were developed and larger profits resulted. As for the owner, the work was completed quicker and at no greater cost. The contract system thus became popular for these various reasons, and especial attention was paid to this system both by owners and engineers. Specifications and detailed plans were developed and complete control of the work was secured. Costs were kept reasonable by the fact that the successful contractors maintained an organization under the best supervision and most up-to-date methods and machinery possible and consequently they could complete work at a comparatively low figure and still make a profit.

Politics Causes Day Labor to Fail

What became of the day labor system in the meantime? Cities, counties and towns, and some states, whose officials were changed every election would commence work by the day labor system. Many times the official in charge would have had no experience in the particular line of work that he sometimes poor and faulty work. About the time the official undertook, and for supervision he would fill these positions with his friends or political supporters. The result of this poorly organized, inefficient supervision was high costs, and became experienced and could have produced satisfactory work at reasonable cost, a political house cleaning removed him from office and the same thing was done all over again by the next official. The day labor system has been abused by such methods as these, and there has never been any great attempt to develop this system to the degree that the contract system has been developed. The force account method may be a step in the development of day labor system, and the cost plus percentage or the cost plus fee method is another stage in the development of the day labor system.

Day Labor System Abused

That the day labor system is being abused is shown by the statement of a well known contractor that I interviewed while looking up facts and information on this subject. This contractor has done considerable highway work and has six large contracts under construction: five of these were day labor or force account work; the sixth was a straight contract. He spent practically all his time on the sixth contract, and when asked why he did this remarked that the other five contracts were day labor contracts and he could not lose anything, but because this was a straight contract he must give it most of his time, and also his best men. This is a bit of the abuse that makes day labor cost more than contract work and this loose control and indifference by officials is the very thing that is condemning the day labor system.

High costs in day labor construction were many times blamed on the principles of this system, when as a matter of fact the real reason was the inefficient organization and the

lack of control. Because of the high costs, many cities and towns immediately condemned the day labor system and without any attempt to overcome the weak points in the system, inaugurated the contract system, a system in which the control and methods had already passed through the experimental state and was on a developed, definite and sound basis.

Conditions Unfavorable to Day Labor

With the same regulations and restrictions, and the same personnel in day labor system as in contract system, both should carry on the work at the same cost to the owner. In the contract system the contractor's profit and payment of the possible contingencies must be added to the costs. A few reasons why the day labor system is expensive is because this system is generally harnessed by laws that limit the payment of the foreman and supervisors, and thus prevent this system the privileges of the high class of supervision of the contract system. Many times the law also states just what the labor shall be paid. This again is a serious obstacle for the day labor system to combat.

The limit of salaries of foreman and supervisors subject the day labor system to many obstacles, for very often it happens that in this day labor system the limit in wages commands supervisors and managers of only ordinary ability, or only partially experienced in their particular line.

The contract system on the other hand is not restricted as to obtaining the best supervision of labor. The successful contractor is a man of exceptional ability; one who represents the survival of the fittest. With this ability and the resources for efficient supervision, the contract system is immediately put on a firm basis.

Therefore it seems that the day labor system should not be condemned through reason of the principles of the system itself but should be passed through a period of development to the same extent the contract system has been developed. It should not be ridden with laws that combat the motives of the system. It is true a few steps have been taken in this development in the form of force account work and in the "cost plus percentage" or "cost plus fee" system. The day labor system will never be universally popular or successful until it is given the same freedom as the contract system, and is controlled by the same standard of supervision and efficiency.

Bonuses

I will only touch the subject of bonuses wherever it can be used in connection with developing the day labor system. It is especially opportune to speak of the subject of bonuses in connection with the development of the day labor system.

In practice, we find that among contract laborers some men do more and better work than others while they all may be receiving the same compensation. This does not encourage the men to do their utmost but is conducive to producing a matter of fact interest in their work. The ideal condition would be a piece rate system; to pay all the men in proportion to the amount of work they turn out. This is not always possible, in each individual case, but it can generally be developed with groups of men at least.

Advantages of Bonus System

By analysis the bonus system means a piece rate system with a minimum guarantee. An interesting fact that happened during the past construction season describes one of the advantages of the bonus system. Two contractors, seven miles apart on the same road, having practically the same territory from which to draw labor, were constructing a concrete road. Both contractors at the beginning paid $4 per day for labor. The one added a bonus system, whereas the other stated he would raise the wage if necessary. The man paying the bonus averaged $4.25 a day in paying for his labor. Consequently he soon drew more and better labor. The second contractor seeing his men leave, raised his wages to $4.25 and then to $4.50 and finally $5, but at no time did he complete as much work with the same number of men as the contractor that paid $4 minimum wages plus a bonus. This was really the piece rate system with a minimum guarantee.

The bonus system made each man a sub-contractor and his wages depended on his efforts and the amount of work completed. If the day labor system of doing work could have the benefit and advantage of this spirit among its labor, a great step in developing the day labor system would have been taken.

While the idea of bonuses seems to be old, it has not been used to any great extent especially among contract labor. The only reason for this seems to be that this branch is another detail not yet developed.

Bonus System Applied to Day Labor

To develop the "bonus system" on construction as it has been developed in the industries, may at the same time make it possible to produce labor that can be used successfully in the "day labor system" and we may then expect many of the present day difficulties for the successful use of the day labor system to be overcome, and we might possibly find the same efficiency and control in this system as is found in the industries. The operation of that system of "day labor" that has been found so costly and so unpopular among engineers may, with the help of the "bonus system" be developed with an economic plan, closely approaching in practice, the theoretical principles of the "day labor" system, and becoming a popular method of carrying on highway construction.

New Method of Handling Brick with Bodies Fitting Any Motor Truck

Heavy materials, such as brick, can be handled carefully by means of the "G-F" bodies that fit any make of motor truck. These bodies are marketed by Greer & Fontaine, of Roanoke, Va. The illustration shows the dump body in the act of standing its load of brick on end in a pile adjacent to other stacks of brick similarly made. Loading time is saved,

SPECIAL MOTOR TRUCK BODY THAT HANDLES HEAVY MATERIALS CAREFULLY.

as one body is loaded while the truck is delivering and returning the other body. It is claimed that it requires less than five minutes to disengage the empty body and take up the loaded body. The saving in time of unloading is obvious

from the illustration. Brick is handled without chipping or breakage, and is neatly piled in smaller space than when dumped and at saving of time and money over hand stacking. The loaded body can be taken from the truck by elevator or chain to the elevation needed, or swung on board a barge. The daily delivering capacity of the truck is increased by keeping it on the move. A truck making four loads per day under the old methods should make from ten to fifteen loads by means of these bodies.

The Manufacture of Pressed Steel Parts

In recent years the manufacture of deep drawn, heavy stamping and pressed steel parts has increased tremendously. Many articles previously made of cast or malleable iron are now successfully formed from steel, the result being a more satisfactory and durable part in most instances. Among the concerns in this business is the Truscon Steel Co., of Youngstown, Ohio. They have been manufacturing pressed steel parts for a number of years, the majority of such work being for use in their own products. Their products now practically cover the entire field of structural building materials.

During recent years they have built up a skilled organization and developed a very complete factory for this type of work. Their large machine shops enable them to make the most intricate dies economically. Their factory buildings cover an area of 12 acres and are amply provided with shipping facilities. There are 2½ miles of trackage on their grounds, furnishing ample sidings throughout the factory buildings proper and for all storage yards. Being located in the center of the steel district, the best service is secured on the delivery of raw materials, and they are in position to ship direct to any point.

The equipment in this plant is unusually complete and provides for a wide range of work. The many presses number into the hundreds and include the most prominent makes, ranging in capacity from small automatic to gigantic pressure machines. These batteries of presses are accompanied with a full complement of shearers, welders, motors, shapers, lathes, grinders, drills, compressors, cranes, trucks, rolling, milling and screw machines.

The variety of Truscon products has necessitated the development of a plant which was of national value in the time of war. It furnished the government with shells and booster casings in quantities, in addition to an unusual volume of pressed steel and heavy stamping work for other concerns.

VIEW ILLUSTRATING MODERN POSSIBILITIES IN THE MANUFACTURE OF PRESSED STEEL PARTS.

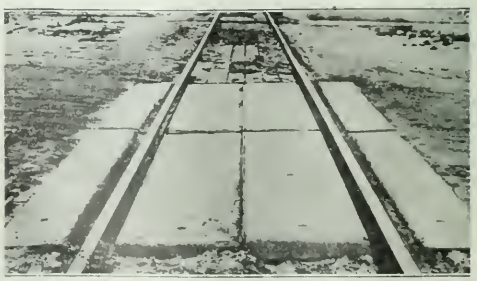
Use of Precast Concrete Slabs at Railway Grade Crossings

Removable, precast concrete slabs, suitably reinforced, are now being used on railroad grade crossings. Two of the best examples of this construction are found at Cedar Rapids, Iowa. These crossings were placed on the Iowa Railway and Light Company's interurban tracks, on the island crossing, and on the Chicago, Milwaukee and St. Paul railway at Ninth avenue, west. Both crossings are the same as when installed over two years ago, and have proven very satisfactory to T. F. McCauley, city engineer.

The cut herewith illustrates the C., M. & St. P. railway crossing after two years of service. Half of this crossing is of plank, and the plank half has been renewed three times. Later designs eliminate the plank outside the rail.

The slabs used were 8 feet long and were reinforced with steel rods and expanded metal. Lewis holes were provided for use in lifting the slabs, which were not fastened to the ties, although that could easily have been done by the use of screw spikes or bolts.

Slabs about 5½ ft. long by 2 feet wide, resting directly on sawed ties, can easily be placed and as readily removed when track repairs become necessary. Their weight should be sufficient to hold them in place, but, if desired, they can be fastened to the ties. A crossing safe against heaving and displacement is assured. Traffic demands an even crossing, with small wear and no heaving. Suitably reinforced, and with edges protected, these slabs should serve satisfactorily for years.



PRECAST CONCRETE SLABS ON RAILROAD GRADE CROSSING.

EDITORIALS

"Public Works or Public Charity?"

A large portion of this issue is devoted to the publication of letters from city and state engineers outlining the construction work to be performed under their jurisdiction this year. Seeing what these cities and states propose doing, other cities and states should do proportionately as well according to their means.

Unless we resort to public works we shall of necessity have recourse to public charity. This is the view of students of economic and labor conditions.

Public Works or Public Charity? is the title of a pamphlet written by Harold G. Moulton, an economist of national reputation. Mr. Moulton is a member of the Department of Political Economy of the University of Chicago. The pamphlet was published and is being given wide distribution by the Union League Club of Chicago. It is also being distributed by the Emergency Public Works Commission of Pennsylvania, and perhaps by other agencies interested in holding stable the social order and in safeguarding business conditions generally.

The title of the pamphlet is self-defining and gives the key to the economist's conclusions. The first sentence of his formal conclusion reads:

"In view of the established facts of our industrial experience and in view of the grave possibility of depression during the transitional era—indeed, I think one may say in view of the facts of the immediate situation—with industry everywhere hesitant, and unemployment already rapidly increasing, is it not perfectly plain that a comprehensive program of public works should be instituted just as soon as possible?"

After stating that "we cannot permit either our returning soldiers or war workers to starve" he says: "We have the choice, therefore, of two methods of meeting the situation: (1) by providing employment on public works of enduring value or, (2) by supporting by public charity an army of unemployed in nonproductive idleness."

Let every municipal, county, state and federal official ask which alternative he will choose. Then let him start public works projects to the limit of his opportunities. If this is not done it will be well to organize soup kitchens and free bread dispensaries for we shall need them soon.

The leading editorial in the August, 1918, issue of Municipal and County Engineering was entitled: How Are the Plans Progressing? It concluded: "City officials who fail to plan now cannot hope to escape the most bitter criticism when the plans are wanted. They will be held guilty of totally inexcusable shortsightedness if not of gross stupidity."

Some cities, many in fact, did plan improvements for construction after the war. Others did nothing, apparently, but read the newspapers. Among the many good letters published in this issue a few are included as giving horrible examples of cities guilty of "totally inexcusable shortsightedness if not of gross stupidity." If ever it was easy to forecast anything it was that we should need improvement programs to stabilize industry at the end of the war. City officials who could plan and did not have demonstrated their unfitness to hold responsible public office and will undoubtedly be returned to private life as soon as the voters can get at them. By the same token, officials who do not now strain every nerve to plan improvements and place them under contract as soon as feasible will undoubtedly be turned out of office at the expiration of their present terms. That is another "cinch forecast."

In their introduction to the Moulton pamphlet the War Committee of the Union League Club of Chicago said:

"There is sound reason for believing that we shall be confronted with a grave unemployment problem during the next few months until war workers and returning soldiers can be reabsorbed into normal industry. The resumption of usual industry will be slow in many important branches.

"Only prompt action by government and municipal agencies through the inauguration of public works on a large scale can avail in meeting the impending critical situation, the consequent acute suffering and the unrest that will follow in the wake of wide-spread idleness. Interrupted work should be resumed at once; deferred work should be begun; new work contemplated for a later date should be promptly planned and be taken up now.

"The community should not postpone public work while awaiting lower costs. The cost of human discontent and resentment will overbalance a small percentage of monetary cost."

Are you ready for the question?

Public works or public charity; which?

Freight Rates on Construction Materials Should be Decreased Not Increased

At this time when the leading officials of the federal

government, and various departments of the executive branch of the government, are urging the beginning of public works construction at any cost as an emergency measure, it is difficult to discuss with patience any movement by the railway administration toward higher freight rates on construction materials. These rates are already too high; to increase them will kill many construction projects on which the immediate welfare of the nation depends.

A hearing was recently held in Chicago, before the local representatives of the United States Railway Administration, on proposed freight increases in one district on sand, gravel, crushed stone and slag, all essential materials of construction. The hearing was well attended by workers in the construction field from the district immediately concerned. The hearing was generally regarded as a try-out, it being the common understanding that if the increase in rates could be "put over" in the district in question and on the materials mentioned, similar increases would be made on other materials in this and other districts. With this prospect in view those who attended the hearing were thoroughly aroused to the imminent peril in the situation. Objections were heard and recorded and the decision in the premises has not yet been reached at the time of writing.

The objections raised were rather pointed in some cases. The suggested increase was frankly, and justly, characterized by some speakers as a thoroughly dangerous and uncalled for measure. The usually long-suffering and tolerant construction folk present were goaded, by this most untimely proposal, into a state of feeling closely approximating open rebellion and elemental wrath. The fact that the proceedings were parliamentary reflects great credit on the self-restraint and forbearance of the audience and, incidentally, demonstrates the fundamental soundness of our organized community life. In any country not so well balanced and even tempered as this, such an occasion would have produced a demonstration bordering on violence. Even so, had the identity of the author of this suggested freight increase been known he would have been made to feel the extreme displeasure with which his proposal was regarded, while remaining safe and secure in his person and estate.

The construction industry has a right to feel that it has been roughly handled in recent months. This is admitted by all. Having been bombarded, gassed, bayoneted and shot during the war, it is now to be throttled, on its way to the hospital, if the railway administration is not closely watched.

The construction industry must arouse itself and take its own part, especially as it has been encouraged to great effort by every agency concerned with the exception of the railway administration. There was gratifying evidence, at the hearing mentioned, that the construction men are not quite dead and may even have a good stiff fight left in them. When the amiable incompetent who presided at the meeting admitted his inability to answer a simple question and blandly and impersonally referred it to "any of the railway gentlemen in the audience" a roar went up from that audience that was an unmistakable sign of life. It was most encouraging. It caused one to feel that no longer will the construction industry remain "dumb as a lamb before her shearers."

There is said to be a sizeable deficit in railway earnings. Maybe so. And then again maybe not. The railways may be losing lots of money under government control but if so they are very complacent about it. The railway managers cannot be accused of undue haste in wanting to get the roads back. They seem to be afraid that they will get them back before they want them. The builder is a straightforward and simple man; he should remember that he cannot believe all he hears, that language is used to conceal thought as well as to express it.

Suppose the roads are losing money, which we very much doubt, but suppose they are. Why pick on a bankrupt industry as the one to make good the deficit? Of all industries the construction industry has suffered most and longest. It should be protected now, not only as an act of justice to a business almost killed by federal fiat, but especially because the entire country is depending on construction to safeguard prosperity this year.

If freight rates on construction materials are increased the volume of construction work will be substantially curtailed, employment for labor will not be provided as planned, and the country will surely suffer.

If the railways need more revenue they must get it some place else. Any further tax on the construction industry will tax it out of existence. Business men, generally, should be asked to co-operate with construction men in the effort to have lowered the freight rates on construction materials. The proposal to lower these rates is logical and just and will so appeal to the public. Pressure must be brought to bear on the railway administration to lower these rates. The co-operation of influential newspapers, chambers of commerce, and officials of the federal government can be easily enlisted in this cause. For example, the Department of Labor is doing everything it can to encourage construction. Perhaps the Secretary of Labor could be persuaded to reason with the Director General of Railroads. That would be a good starting point. No effort should be spared to have these freight rates lowered. A well organized and well sustained effort in that direction will surely succeed. Who will start it?

City and County Engineers Write of Construction Projects Planned to Provide Buffer Employment for Labor during Readjustment Period

The construction of public improvements of all sorts is urged by federal officials, economists and business men everywhere as a means of taking up the industrial slack while the country is being changed over from a war to a peace basis. That cities and counties are ready to do their share in providing work for the laboring classes is clearly shown by numerous letters to the editor of MUNICIPAL AND COUNTY ENGINEERING. The letters demonstrate the sympathy of city and county officials with this nation-wide movement to turn to construction as the only safeguard of prosperity in the present emergency. Many of the letters received by the editor are published herewith. They give much specific information on work planned for 1919:

Springfield, Ill.

Willis J. Spaulding, Commissioner of Public Property in the city of Springfield, writes:

"In reply to your inquiry regarding public work under the jurisdiction of the Department of Public Property, which may be undertaken as part of the general effort to take up slack in labor, our department has in view the completion of a 24-in. trunk line about 1½ miles in length which will cost something over $100,000; also the replacement and enlargement of our water distribution capacity in the downtown district which will cost perhaps $30,000 more. We also expect to make additions and extensions in our electric department for taking on commercial business, which will cost perhaps $75,000.

"We agree with you that the promotion of public work is important. Personally, I feel that while this movement will help some, it will be altogether inadequate. We are referred to the period immediately succeeding the Civil War as evidence that we need have no fears for the immediate future. At that time the country had vast areas of unoccupied lands to absorb all surplus labor. This is now practically all gone and unless some comprehensive reclamation scheme, such as Mr. Lane has outlined, is vigorously pushed, I look for a great deal of unemployment."

Milwaukee, Wis.

T. Chalkley Hatton, Chief Engineer, Milwaukee Sewerage Commission, writes:

"I beg to advise you that the Sewerage Commission of the city of Milwaukee has made plans and secured the necessary funds for carrying out about $1,014,000 worth of new work during the coming year and are now letting out contracts governing the construction of such work and will continue so to do as rapidly as the season is such that outside work can be properly carried on. In addition to this, there are seven contracts for outside construction, amounting to approximately $800,000, being carried on—that is, hanging over from last year.

"The Sewerage Commission has no desire whatever to hold up any work that can be properly carried on during this year and has, during the past six months, made every effort to have plans ready and money on hand to carry on as much work as possible after the war was over, as this method would be highly desirable for employing men released from strenuous employment during the war."

Fond du Lac, Wis.

J. S. McCullough, City Engineer of Fond du Lac, Wis., writes as follows:

"I beg to advise that our Commission has authorized us to prepare plans for a number of improvements to try to take care of the expected labor situation the coming season. The city authorities are making every effort to provide as much work as possible for the returning men, and the following work is practically assured: 22,500 sq. yds. paving; 17,000 lin. ft. combined curb and gutter; 4,700 sq. ft. of re-paving, aggregate cost approximately $60,000; about 1¾ miles of sewer work of various sizes, aggregate cost approximately $25,000; and renewal of bridges to the extent of $20,000.

In addition to this there is reasonable expectation of park improvements, including a recreation or memorial building, details of which have not yet been worked out, and the probable expenditure will be in the neighborhood of forty to fifty thousand dollars.

"The above projects will undoubtedly be carried through, and as the season progresses other sewer and pavement work is likely to be added."

Joliet, Ill.

C. D. O'Callahan, City Engineer, writes as follows:

"The city of Joliet, appreciating the necessity of furnishing employment to labor released from war activities, is engaged in the preparation of plans for public improvements, the estimated cost of which is $250,000. This work consists mainly of street pavements by special assessment. Improvements costing several times this amount are dire necessities of this municipality, but on account of the antiquated basic law of the state of Illinois, the cities are so restricted in issuing bonds or raising taxes to pay for improvements, that little can be done by Illinois cities except that which comes under the Special Assessment Act, and as this imposes the cost on only a portion of the citizens, at a time of high prices it should only be worked along justifiable lines.

"The state could in a large measure absorb the unemployed labor and materially assist in effecting a satisfied labor market by being prepared to let contracts on the $60,000,000 bond issue for good roads on 30 days' notice. I appreciate that a large amount of preliminary work is required before the State Highway Board can let contracts on this work, but believe that if such a policy as the Army and Navy used for intensive training of the young men for military service was applied to clearing up matters preparatory to starting actual work, that contracts could be let by May 1, 1919.

"There is a justification for speedy work along such lines and of being prepared to give employment to a large volume of unemployed men when, on account of high prices, the lack of employment will bring privations on millions of our people and will tend to cause industrial outbreaks."

Dayton, Ohio

F. O. Eichelberger, City Engineer, states that the following work is proposed for 1919:

Approximately 1.35 miles of brick pavement, 28,965 sq. yds., to cost $176,367; approximately .39 miles of wood block and granite durax paving, 13,400 sq. yds. wood block and 4,250 sq. yds. durax to cost $112,560; approximately 13.5 miles asphalt street repair to cost $33,000; approximately 6 miles brick repairing to cost $17,800; approximately 47.5 miles street oiling to cost $45,000.

Louisville, Ky.

John Chambers, Chief Engineer, Louisville Department of Engineering, writes:

"The complete construction program of the city of Louisville has not yet been prepared, but it is reasonably certain the following list will be included: Finzer avenue, Cherokee to Bardstown Road, 1 block; 15th street, Main to Walnut, 4 blocks; Breckenridge street, Logan to Barrett, 4 blocks; Hill

street, 3d to 4th, 1 block; Bank street, 25th to 26th, 1 block; 13th street, Market to Jefferson, 1 block. All of the above items with the exception of 15th street and 12th street, are to be in asphalt."

Akron, Ohio

E. A. Zelsloft, City Civil Engineer, Akron, writes as follows with reference to the program for proposed construction work to be undertaken in 1919:

"At the present time we have a paving program to the amount of $500,000; a program of sewerage to the amount of $195,000. This work is to be done this year, as the money is now in the fund to proceed.

"On March 4th the city will place a bond issue to the amount of $3,000,000 to the vote of the people, which if passed, will be used to commence the construction of a new sewerage system in this city, estimated to cost ultimately $10,000,000."

Buffalo, N. Y.

Geo. H. Norton, City Engineer of Buffalo, writes:

"While not under this department, the largest project under way by this city is in school building under an $8,000,000 program to include high school enlargement, grammar schools and twelve intermediate grade schools. This is under the school board.

"The largest construction items contemplated by this bureau are two storm-water drains. The cost of the two will be above one and one-half million dollars, and it is hoped to get some of the work under contract this year. Plans are under way but not completed. Three viaduct structures are to be partly rebuilt and work will soon be advertised.

"Dredging work will probably be continued on Buffalo river navigable channel and some improvements made in the lower river. This work will necessitate two new bridge structures, but nothing is yet definitely decided relative to them.

"Work will be continued on the Bird Island Pier dock and sewer extension under existing contracts. Three small pieces of dock aggregating about 250 ft. in length will be constructed, but plans are not yet completed.

"Paving work is uncertain in extent and much will depend upon prices and upon track construction by the Traction Company. Probably will be from 10 to 15 miles, including repaving.

"The Bureau of Streets expects to construct a new stable and also new storehouse. Funds and land for the former are provided.

"The Bureau of Water expects to extend a new 60-in. duplicate discharge from the Col. Francis G. Ward Pumping Station and to make other extensions.

It is the policy of the Council to put as much of this work as possible under contract at an early date, or as soon as contract conditions are sufficiently stabilized."

New Haven, Conn.

F. L. Ford, City Engineer of New Haven, writes:

"The city of New Haven, Connecticut, has bonds authorized and plans prepared for building the Tomlinson Bridge, estimated cost $500,000, and bridges on Orange street, and Willow street, costing about $40,000 each. Also for an enlargement of the city wharf, $250,000. Also for sewers, $300,000. Authority will soon be asked for $200,000 for street paving, much of this work was postponed on account of the war. Bids on some of it will be received as soon as prices on steel and cement are more favorable."

Mankato, Minn.

Harvey S. Dartt, City Engineer of Mankato, writes:

"In Mankato work on water and sewer extensions, storm sewers, roads and pavements will be pushed the coming year as rapidly as finances and good judgment will permit. No big projects are in view and there will be enough small ones left over to keep everybody going for the next two or three years. Mankato will do its full share to furnish employment for the manpower released by the close of the war."

McPherson County, Kansas

H. A. Rowland, Engineer of McPherson County, Kansas, writes as follows of the probable work to be done during the season of 1919:

"I will list the following:

"Lindsborg, Kan.—The city will soon advertise for bids upon 2 miles of brick paving, H. A. Rowland, engineer.

"McPherson, Kan.—The county commissioners have named a board of trustees to take charge of the erection of a county hospital to cost approximately $100,000.

"McPherson, Kan.—The Blaze Fork Drainage Board expects to call for bids soon for the construction of drainage ditches making an excavation of approximately 160,000 cu. yds. H. A. Rowland, engineer.

"McPherson, Kan.—The county will soon receive bids for about $15,000 worth of bridges and culverts."

Leadville, Colo.

Fred J. McNair, City Engineer of Leadville, writes:

"I beg to say that it is the intention of the city of Leadville, Colo., to improve the main automobile highway from one city limit to the other this year. This will include grading and surfacing, and the reconstruction of the concrete crossings on Harrison avenue."

Minneapolis, Minn.

Frederick W. Cappelen, City Engineer of Minneapolis, writes as follows regarding work for this year:

"I beg to state that money has been provided for the following items:

Paving and curb and gutter	$489,000
Oiling	217,000
Grading streets	173,000
Maintenance of dirt streets	288,000
Sewers	225,000
Water department	350,000
Bridges	25,000
Sidewalks	150,000

"Work proposed, depending on the sale of bonds, for which we have authority:

Paving and curb and gutter	$231,000
Sewers	150,000
Grading	300,000
River terminal	170,000

"Work contemplated for the next two years, for which we are requesting the present legislature authority to issue bonds for, for the city's portion of cost of work, in addition to such sums that may be set aside by the Board of Tax Levy:

Paving and curb and gutter	$400,000
Sewers	400,000
Bridges	600,000

"We have to get this authority from the Legislature now in session, because the Legislature will not meet again until 1921.

"In addition to the above work, the city council this afternoon (January 20) authorized me to start four trunk sewers, and four crews for laying water mains, and to do some river work and some grading; by which I can employ about 525 men of which about 400 will be soldiers, whose credentials will be honorable discharge papers, and citizens of Minneapolis, first; and if we cannot get enough men of this character, then discharged soldiers from elsewhere who may now wish to work in Minneapolis; and if we cannot get enough soldiers of this kind, then of course we will employ our own laborers.

"You will of course appreciate what it means to order this kind of work in this latitude at this time of year, but it is to show the city's willingness to do the utmost for homecoming soldiers at this time."

Kansas City, Mo.

Robert W. Waddell, City Engineer, gives the program of Kansas City up to January 21st, for the coming year:

"The following work is assured:

Twenty-third street viaduct	$ 800,000
Union Station approaches	130,000
Turkey Creek sewer	1,100,000
Granite paving west bottoms & Bluff St.	254,000
Thirty-first St., Pennsylvania to Main	14,000
General paving	750,000
District & Joint District sewers	400,000
Street repairs	200,000
Misc. work grading, curbing, etc.	100,000
	$3,748,000

"The following work is probable:

Sixth St. paving, brick	$ 60,000
Twelfth St. paving, brick	100,000
Summit St. paving, concrete	48,000
Beardsley St. paving, brick	75,000
Grand Ave. paving, wood blks. or brick.	215,000
Independence Ave. paving, brick	106,000
McGee St. trafficway paving, brick	120,000
Fifteenth St. paving, asphalt or brick.	225,000
Eighteenth St. paving, asphalt or brick.	45,000
Raytown Road paving bitulithic or conc.	75,000
Blue River sewer	2,500,000
East Bottoms dike	900,000
	$4,469,000

Cleveland, Ohio

Robert Hoffman, Commissioner of Public Service and Chief Engineer, writes:

"It is difficult at present to furnish any very reliable statement of the amount of public work which may be placed under contract by this department the coming season. We have begun to take bids on both sewer and paving construction. We expect to place contracts during the season covering $1,500,000 worth of work in connection with paving of streets, and an equal amount in connection with the construction of sewers. We shall also probably place under contract $1,000,000 worth of work in connection with sewage disposal.

"We are making every effort possible to provide for as large amount of construction work as can be financed and properly planned and supervised."

Colorado Springs, Colo.

F. F. Mallon, City Engineer of Colorado Springs, states that: "Owing to the legal procedure necessary to promote improvement districts in Colorado Springs, it is quite impossible for us to get in shape to do any work of an improvement nature during the forthcoming construction season. Hence, it would be 1920 before we can start operations on the work we now contemplate.

"It is proposed to pave ten blocks on 17th street, so as to act as a substitute for a storm sewer. At least three or four miles of curb and gutter district will be installed. There is a reasonable possibility of Colorado avenue being paved from Colorado Springs to the Manitou connection, which embraces perhaps, 35 blocks. A decorative lighting system is to be installed between Nevada avenue and the Santa Fe depot on both sides of Pike's Peak avenue, which is about five blocks. This is as much contemplated work as we have in view at this time."

Fort Worth, Texas

F. J. Von Zuben, City Engineer, gives the following information:

"Paving or Road Building Work: The city of Fort Worth has just begun the resurfacing of a portion of Evans avenue in this city and contemplates immediate maintenance work on a number of other streets to the amount of $50,000. We are also surfacing Vickery boulevard and North Twenty-fifth street with asphalt (graveled roads), and paving the connecting link between East Front street and the Dallas Pike; North Main Street viaduct; North Houston and North Commerce streets with vitrified brick. All of these jobs are being done by contract on the cost plus basis.

"Waterworks and Sewerage: The addition to the water works filtration plant consisting of four 1,250,000 gal. rapid sand filters, together with the necessary equipment and additional sedimentation basins, aeration basin and chemical house, is rapidly being completed. This addition practically doubles the output of our water purification plant, and will make a marked improvement in the water furnished.

"Regarding the sewage disposal plant, will advise that it is the intention of our Board of Commissioners to submit a bond issue for sewage treatment works at the coming election in April."

Board of Water Supply, City of New York

J. Waldo Smith, Chief Engineer, writes:

"During the present year we shall continue work on the Schoharie tunnel and the force engaged will be materially increased as the shafts reach grade and as the tunnel excavation is begun. (The Schoharie tunnel is 18½ miles long and will be excavated from one portal and eight shafts.)

"Additional work on the Schoharie project includes the Gilboa dam, an overfall masonry structure 1,500 ft. long, having a maximum height of about 160 ft. The masonry dam will be flanked by an earthen wing dam 500 ft. long. New highways around the Schoharie reservoir will have a length of about 12 miles, and it is now anticipated that, under favorable conditions, all parts of this project will be under way during the coming season."

Water Division—City of St. Louis

Edward E. Wall, Water Commissioner, St. Louis, writes:

"The construction work proposed in the Water Division of the city of St. Louis for the year 1919, will consist merely in the completion of contracts already let and under way; namely, reconstruction of the boiler plant at the Baden station, involving a total expenditure of about $260,000. This reconstruction consists of the installation of eight new 350 H. P. water tube boilers, together with chain grate stokers, coal bunkers, scales, ash conveyor, etc., necessary for the complete equipment of the power plant, with automatic machinery for its operation.

"The completion of a 7 ft. reinforced concrete conduit connecting the storage basins at Baden with those at Bissell's Point, a distance of about 3½ miles, for the purpose of increasing the quantity of water which can be supplied to Bissell's Point station from the Chain of Rocks. The total cost of this work will be about $300,000. An ordinance for the appropriation of $300,000 or more will be introduced for the purpose of covering the storage basins at Bissell's Point and at Baden. It is hoped that the contracts for this work can be let early this year.

"About 100 miles of water mains that have been in service 20 years or more will be cleaned this year by the National Water Main Cleaning Company.

"These items of construction will take up all of the available funds belonging to the Water Division that can be spared from the necessary expenses of operation and maintenance, which have so largely increased in the past year as to reduce the usual annual surplus for extensions by at least one-half.

"It is not only the policy of the Water Division of this city to provide all the work for which we are able to pay during this readjustment period, but also to reinstate all men who have left us for war work in their former positions or in others equally as good."

Borough of Manhattan, City of New York

C. M. Pinckney, Chief Engineer, in giving a brief summary of the proposed construction work to be undertaken by the Department of Public Works, Borough of Manhattan, for 1919, writes:

"Up to this writing a definite policy to be pursued in the

conduct of public works has not been determined. I believe, however, you would be safe in assuming that in Manhattan Borough repaving will be undertaken to the extent of $3,000,000; sewer construction to the extent of $1,000,000, and a possible short piece of structural steel viaduct will be erected at 134th street and Riverside Drive."

Pawtucket, Rhode Island

George A. Carpenter, City Engineer, writes:

"I am obliged to say that no definite amount of work has yet been decided upon by the city government. It is quite likely that we may lay about 14,000 sq. yds. of grouted granite block pavement on a concrete base and may build about 3,400 ft. of sewers varying in size from 44 ins. to 60 ins.

"It is very probable that additional work will be done but no decision has been arrived at which enables us to give you an approximate idea of the amount."

Department of Public Works, Philadelphia, Pa.

George E. Datesman, Director, writes as follows of the improvements contemplated by Philadelphia:

"I desire to say that our plans provide for the expenditure of approximately $10,000,000. Of this sum, we plan to spend $2,250,000 on new bridges, sewers, and the abolition of grade crossings. A like sum is considered in our plans for highway improvement, and about $5,000,000 is contemplated for the improvement of the water supply.

"The amount for new bridges and sewers may be considered as available, and the sum mentioned for highway improvement is somewhat in a similar position. Some of the amount for the improvement of the water supply may also be considered as available."

Utica, N. Y.

Joseph Kemper, City Engineer, writes as follows:

"Our construction program for the season of 1919 is not settled, being dependent upon future ordinances directing work and bond issues required therefor, which will soon be introduced.

"However, it may be stated that the city will probably spend about $200,000 in new pavements and resurfacing work and about $30,000 in new sewers. It is the desire of the administration to promote all possible construction work in furtherance of the very great necessity for providing work during the reconstruction period.

"It is also expected that the first steps will soon be taken towards the erection of three new school houses."

Providence, Rhode Island

Walter F. Slade, Commissioner of Public Works, writes:

"I beg to advise that the expenditures of this department for the current fiscal year, ending September 30th, will be within the present balance of the appropriations made by the City Council as follows:

For highways	$260,236
For sewer construction and maintenance	218,325
For water works	273,432
For street cleaning	136,909
For bridges	35,265
Total	$924,167

of which about 38 per cent. will be expended for materials purchased out of town.

"On October 1st a new appropriation will be available, the size of which and the amount to be expended therefrom will be determined by the City Council."

Clarke County, Wash.

B. L. Dorman, Engineer of Clarke County, Washington, writes as follows relative to proposed county improvements during the year 1919:

"Clarke county proposes to hard surface the River Road from Vancouver to Washougal, a distance of 15 miles this year at a cost of about $350,000.

"Also at least three miles of the Pacific highway at a cost of about $60,000.

"Other improvements in road work by the County Commissioners will amount to about $120,000."

Detroit, Mich.

H. H. Esselstyn, Commissioner of Public Works, writes:

"I am submitting herewith figures covering the work done in the past year and I would estimate as a reasonable probability that at least one-third more work will be done in 1919 than the following figures show. This is due to the fact that, in the month of October, the paving and sewer work, not actually started, was ordered stopped by the Capital Issues Committee of the War Industries Board which order has, I believe, since been recalled.

Paving, new work	$2,476,246
Resurfacing and repairing	2,302,000
Public sewers	542,345
Lateral sewers	703,522

"We have an appropriation of about $6,000,000 for the construction of public sewers in the city of Detroit, which appropriation has not been available for the reason that bonds could not be sold, on order of the Capital Issues Committee, but the same will, no doubt, be available for this year's work. Should this be the case, it will furnish the necessary outlet and drainage for many lateral sewers and street and alley pavements which are of necessity being held up pending the proper drainage.

Corpus Christi, Texas

H. A. Stevens, City Engineer, summarizes conditions as follows:

"Pavements—No projects at present being considered. Water mains—Minor extensions only. Sewers—Minor extensions only. Water works—Completion of $40,000 reservoir now being constructed. Miscellaneous—Possibility of construction work being started on a plan of shore protection for our Bay Front. Nueces County—County will vote on a bond issue for constructing 175 miles of hard surfaced roads."

Salt Lake City, Utah

Sylvester Q. Cannon, City Engineer, writes:

"Replying to your letter relative to proposed construction work to be undertaken under my direction during 1919, and also as to the providing of "buffer" employment during the readjustment period, I desire to inform you that at the present time the proposed construction work for this year has not been definitely determined. However, the City Commission is preparing for a bond election which will provide for the issuance of $2,000,000 in bonds for various improvements as listed below. The election will probably be held about Feb. 20, 1919. If carried affirmatively a large part of the work will probably be completed this year. If it fails the improvements for the year will doubtless be rather limited.

"In the meantime, in order to provide employment for returning soldiers and sailors, the City Commission has authorized me to undertake emergency work. We are at present employing about 70 men, most of whom are returning soldiers, in construction of a road on West Canyon street, which will be a part of the boulevard system. When this work is completed we propose to dig water main trenches and lay water mains, employing returning soldiers and sailors as far as possible. This work will probably provide employment for most of the men until other improvements are definitely started.

"The general program proposed under the bond issue is in general as follows:

"For a large water supply conduit of reinforced concrete, leading from the mouth of Parley's Canyon to the N. E. portion of the city, and for various cast iron feeder water mains throughout the distributing system $500,000

"Securing additional water rights by exchange or purchase and the development of sources of local

supply	$250,000
"The conservation and development of the City Creek water supply (additional reservoir)	100,000
"Storm sewers throughout the various portions of the city	226,000
"The city's portion of sanitary sewers	50,000
"Three permanent bridges over the Jordan River and Surplus canal	35,000
"The city's portion of about 15 miles of street paving, including the lowering of water mains	250,000
"The city's portion of sidewalk improvements	20,000
"The city's portion of curbing, guttering and grading of various districts including the lowering of water mains	100,000
"Municipal bathhouse at Warm Springs and parking of grounds	200,000
"Liberty Park improvements and buildings	97,000
"New parks and boulevard improvements	35,000
"City cemetery improvements	27,500
"City's contribution to the Soldiers' and Sailors' Memorial	100,000
"Comfort Station, business district	9,500

Lincoln, Neb.

Adna Dobson, City Engineer, writes:

"It is impossible to give any definite idea of the probable amount of construction work to be undertaken by the city during the year 1919. A great deal depends on the cost of labor and materials. A large amount of pavement will be laid if the price is not considered out of reach. In our city no paving can be undertaken until a petition is filed, signed by a majority of the property owners in the district. A great many districts are under consideration, but no petitions have yet been filed.

"Under ordinary conditions we would probably lay 100,000 to 150,000 sq. yds. of pavement; costing approximately $200,000 to $250,000, and we hope that conditions will permit of our doing this amount of work the coming year.

"The only construction definitely decided upon is the construction of some storm sewers amounting to about $12,000.

"A very large amount of county road construction is under consideration, and unless the price is considered excessive, we will have a very large mileage of county paving during the coming year. It is impossible to make a definite estimate this early in the season. Within the next 60 days a great many of these projects will develop and we can form a better idea of the amount of work which will be done."

Charleston, S. C.

J. H. Dingle, City Engineer, writes:

"We are advertising at present for bids for 20,000 sq. yds. of sheet-asphalt pavement. Other work will probably be advertised later, depending in a great measure upon bids received at the present call."

Oil City, Pa.

B. B. Weber, City Engineer, writes:

"We expect to construct about two miles of sewers, from 6 to 12 ins. in diameter, about one mile of cast iron water mains, and build a new boiler house and boilers at the water works pump station. Oil City did so much paving a few years ago that we are not planning any new work of that kind, but there will be considerable expenditure for maintenance."

Passaic, N. J.

Colin R. Wise, City Engineer, writes:

"In view of the cessation of war industries and the consequent throwing out of employment of thousands of war-workers, to which number must be added the thousands of demobilized soldiers, our Board of Commissioners believe, that in order to assist in bridging the gap between war demobilization and peace mobilization, which latter will take some time to effect, it is best to proceed at once with street and sewer work, deferred on account of the exigencies of war, and so we will lay about 21,000 sq. yds. of sheet-asphalt, and 1,200 sq. yds. of granite pavements at a cost of about $77,500.

"We will also build about 5,000 lin. ft. of sewers from 8 in. to 30 in. in diameter. This work includes connections with the main intercepting sewer of the Passaic Valley sewerage commissioners. The cost of this work will approximate $82,500.

"In addition to the above this city will expend about $50,000 as its share of the cost of eliminating the grades of two streets where they cross the tracks of the D. L. & W. R. R. Co., the total cost to city and railroad approximating $375,000."

Washington, D. C.

The Engineer Commissioner of the District of Columbia, writes:

"Appropriations are now available for the erection of a number of municipal buildings, but it is impossible to proceed with the work at this time as the limits of cost fixed by Congress were based on pre-war estimates. The amount of money available for building construction is approximately $1,000,000, but at present prices of labor and material the work authorized will cost approximately double this amount. It is hoped that it may be possible to undertake the work in the near future, but this is contingent upon a decided change in the price of labor and material or upon the granting by Congress of authority to disregard the present limits of costs, or to a combination of the two.

"For the construction of new streets and roads there is available approximately $650,000 and about half as much is available for sewer work. In the highway and sewer work the Commissioners are also somewhat handicapped by the fact that specific appropriations were in many cases made for specific items of work, which cannot be undertaken at the present price of labor and material. Such work as can be placed under contract will be undertaken in the near future."

Spokane, Wash.

A. D. Butler, City Engineer, writes:

"We have under contract at the present time the paving of 14th avenue, from Grand Boulevard to Monroe street, the contract price for which is $34,000. Also, Trent avenue paving, from West Trent avenue bridge to vacated Grant street, the contract price for which is $15,500.

"At the present time I do not know of any improvements other than these mentioned that are likely to go through. It was proposed this winter to start the construction of a downtown intercepting sewer. This office prepared plans and specifications for this improvement, but at a hearing held Jan. 20, before the City Council, the improvement was indefinitely postponed."

Fargo, N. D.

W. B. Stevenson, Acting City Engineer, writes:

"We have under construction at the present time a portion of the trunk sewer system upon which work was commenced in 1917. There remains about $15,000 worth of work under this contract which will undoubtedly be pushed to completion during the spring and summer months.

"There are at present no other projects either in paving, sewer or water construction work, but we have several jobs of paving which are needed and which I hope to see under way before spring work opens up. These include 26,000 yds. of new paving, 13,000 yds. of resurfacing and about 8,000 yds. of repair work, which will include replacing base and surface. In addition to this there is probably about $25,000 worth of water mains and lateral sewer work.

"The public officials remain uncertain about new construction work for the purpose of furnishing employment during the transition period from war conditions to peace and in fact have expressed their unwillingness to undertake any new work on account of the present high price of labor and ma-

terial. However, we hope to overcome their indifference to the problem that is present. I personally have been endeavoring to overcome the indifference of public officials to this class of work and we hope to take the matter up more fully at the meeting of the North Dakota Society of Engineers, which meets at Valley City, N. D., Jan. 30 and 31."

Board of Public Service, City of St. Louis, Mo.

W. W. Horner, Chief Engineer, Sewers and Paving, writes:

"About two months ago St. Louis began preparation of a program for public works to be paid for out of the proceeds of a municipal bond issue. The city's indebtedness is limited to 5 per cent. on the assessed valuation, but the outstanding bonds are so small that it is still possible to issue $23,500,000. The mayor appointed a committe of representative citizens to act with the members of the Board of Public Service in passing upon the need of funds for construction as presented by the various departments. The total budget submitted amounted to $38,000,000 for the immediate needs, and $93,000,000 for all projects suggested. The committee has tentatively reduced the $38,000,000 requested to within the allowable limit, and its program now contains the following items:

River des Peres, main drainage	$10,495,000
Parks and playgrounds	2,850,000
Sewers	3,420,000
Municipal auditorium	1,000,000
Municipal farm	400,000
Free bridge approach (additional southwest)	1,100,000
Belt railroad and docks	1,900,000
Street opening and widening, city's share	750,000
Grade crossing elimination, city's share	1,034,000
Fire engine stations	250,000
Bellefontaine farm	150,000
Additional jail cells	85,000
Total	$23,384,000

"It is expected that the committee will finish its work within the next ten days, and that an ordinance will be submitted calling for a special election to authorize the bond issue, which election cannot be held until about June 1. Allowing a reasonable time for the sale of the bonds and the passage of particular ordinances, and of advertising for bids, it is evident that no contracts could be awarded before September. On account of the shortage of engineering employes many of our designing offices have been practically closed down, and a great deal of engineering work remains to be done on all of these projects. I should say, therefore, that the proposed bond issue presents large possibilities for the year 1920, and a portion of it may be under way in the fall of 1919. In addition to the proposed bond issue work, the city has now authorized and lying on the shelves, projects for sewers and paving amounting to probably $1,500,000. There is no obstacle to the putting of this work under contract in the immediate future if conditions warrant. The administration, however, is in a peculiar position as to this work for the reason that while it is highly advisable, in order that construction business may be revived and employment offered for the returning soldiers, yet, on the other hand, the cost of this work will be very high, and will not be borne by the general public, but will be taxed directly against the property immediately benefited. The carrying out of much of this work is of immediate importance to the city as a whole, and will be of considerable value to the property taxed, but at the high prices at which it probably will be let these taxes will, in many instances, be from one-third to one-half of the market value of the land.

"In order to secure more definite information, we are now preparing to receive bids on about March 1, for paving work amounting to about $500,000, and about $100,000 worth of sewer work. Some of this work undoubtedly will be awarded, regardless of price conditions, and if there is an appreciable decrease from last year's high prices we hope to be able to put all of it under contract. A marked decrease in price would enable the letting of still additional work which we now feel that cheap property in the outlying districts cannot pay for.

"On the whole I should say that there is a possibility of carrying a very good program this year, and a very good probability that the year 1920 will see one of our biggest construction programs."

Oshkosh, Wis.

George Randall, City Engineer, writes:

"Improvements proposed for the city of Oshkosh for the season of 1919 are as follows: Pavements, 15,000 sq. yds.; 7,500 lin. ft. of cement curb and gutter. Sewers, 1,000 lin. ft. of 15-in. pipe sewers; 300 lin. ft. of 12-in. pipe sewers. Bridges, 1 bridge across Fox river, lift bridge, will probably cost about $175,000."

Albany, N. Y.

Frank R. Lanagan, City Engineer, writes:

"The construction work to be undertaken in Albany during 1919 depends upon competition in bidding and the ability of contractors to obtain materials and common labor. The work contemplated at this time includes the construction of two public schools and about 136,000 sq. yds. of pavement construction, divided as follows: Redressed granite block, 62,500 sq. yds.; dressed granite blocks, 8,500 sq. yds. and asphalt, 65,000 sq. yds. In connection with the pavement construction there will be curbing and concrete sidewalk work. No decision has yet been reached as to what sewer work will be undertaken, but a trunk sewer about a mile long from 30 to 60 ins. is in contemplation, besides the laying of a number of local sewers of 12, 15, 18 and 24 ins. in diameter."

Seattle, Wash.

A. H. Dimock, City Engineer, writes as follows on proposed construction work:

"Water Supply: We expect to let contracts at an early date for the extension of the Volunteer Park Reservoir and for the construction of an impounding reservoir at Swan Lake, together with an outlet tunnel therefrom. The total cost of the work which will be under way in the near future will be about $1,500,000, this being the initial construction of extensions to cost approximately four million dollars.

"Power Plant: It is not likely that any large expenditures will be made in this connection this year, the work being confined to its preliminary phases.

"Sewers: A considerable amount of sewer construction will be undertaken in the near future, amounting probably to $1,000,000.

"Main Thoroughfares: The amount of this work to be undertaken during the year will probably be about $2,000,000.

"Bridges: Bond issues providing for the construction of bridges in the amount of $1,650,000 are being submitted to a vote of the people in March.

"Miscellaneous Improvement Work: Probably two or three million dollars. Construction work has been greatly curtailed during the past year, being less than one-half of that in the preceding year. In the meantime the city has been growing rapidly, so that extra efforts will be necessary in order to catch up. The only obstacle in the way to a large program of construction is the prevailing high prices."

Water Department, Baltimore, Md.

Walter E. Lee, Water Engineer, writes:

"The Water Department of the city of Baltimore will either design, install or construct during 1919, the following work which has been postponed by war conditions:

"Immediate installation of 32 operating tables for Montebello filters, contract having been awarded the American Water Softener Co., of Philadelphia, at $23,500.

"Immediate installation of 30, 36 and 48-in. suction mains

to improve operating conditions in Mount Royal Pumping Station, Baltimore, at the estimated cost of $30,000.

"Commencing immediately, the installation of approximately 20 miles of water mains of various sizes and the installation of house connections at a total cost of $100,000 in advance of improved paving.

"Immediate issuance of specifications for furnishing and erecting a 30,000,000 gal. centrifugal pump, driven by a steam turbine having water works condenser, at approximate cost of $75,000.

"Probable erection of experimental filters for comparing efficiency of mixing coagulants at Montebello filters.

"Immediate preparation of plans for new filtration plant of a capacity of 120,000,000 gals. per day, as an addition to the existing filtration plant of 128,000,000 gals. per day capacity."

Jackson, Mich.

A. W. D. Hall, City Manager, writes:

"Our 1919 budget was completed on Oct. 15, 1918, at which time the government was requesting all municipalities not to plan on any public work so that it would be impossible to plan on doing any public work in this city except through the issuing of bonds at the spring election.

"It is possible that we will do a certain amount of work, the payment of which shall be taken care of by a bond issue, however, we have not decided upon this as yet."

South Bend, Ind.

Frederick J. Anderson, City Engineer, writes:

"It is difficult for us at the present time to make any estimate as to the amount that will be done.

"We have under consideration at this time about 135,000 sq. yds. of paving, but the proceedings have not advanced far enough to enable us to tell how much of this will actually be constructed. Petitions for pavements are coming in rapidly, however.

"Very few petitions are being received for sewers, and those that are being received are for short sewers requiring small pipe."

Kansas City, Kan.

Wm. Barclay, City Engineer, writes:

"Practically all grading, curbing, paving and sewer work is originated by petition, so it is not easy to forecast probable work for 1919. State law limits amount of curbing and paving to $300,000 for any one year. This will not likely be reached; grading possibly will reach $40,000, and sewer work, $50,000. About $25,000 will be a fair estimate for bridge and culvert work."

Kalamazoo, Mich.

A. Lenderink, City Engineer, writes:

"The program for the year's work has not as yet been definitely decided upon, but the following is an estimated report:

"Pavements	$125,000
Water extensions	40,000
Sewer extensions	60,000"

Ogden, Utah

Joseph M. Tracy, City Engineer, writes:

"I cannot give you anything definite upon our proposed construction program for this year, but it seems very likely that the program I will list below will be carried out. It will be necessary for the city to call a bond election to cover a portion of the cost of these improvements if they are undertaken this year. I will state that I am in sympathy with this movement for 'buffer' employment at this time, especially during the readjustment period, and it is the aim and intention of the city of Ogden to do a maximum amount of construction work during 1919 and 1920. Following are the proposed public improvements for Ogden City, Utah, for the years 1919 and 1920:

"Paving: Forty-one blocks of paving, kind of pavement not being determined at this time, with an estimated yardage of 193,430, at a total cost of $613,262.55. This, of course, includes curbs and gutters and sidewalks.

"Municipal Lighting and Power Plant: It is proposed that Ogden City construct and operate a municipal light and power plant. Nothing definite as to whether the plant will be a steam or a hydroelectric plant has been decided at this time, but the engineering department is gathering information and data on the subject and will no doubt submit a plan to the Board of Commissioners in the near future. This proposition, however, is not definite as yet.

"City and County Building: Matters are now shaping themselves and I can state with almost certainty that the city and county will proceed immediately to construct a city and county building at an approximate cost of $500,000.

"In addition to the above it is proposed either to build a monument or construct some useful structure, such as a gymnasium, in honor of the soldiers from Ogden and Weber county who took part in the war which just closed. These structures are most likely to be built this year, but cannot as yet state definitely just what will be done."

Bay City, Mich.

H. C. Thompson, City Engineer, writes:

"We have not ordered any work for this season, but I am going to recommend an appropriation of $80,000 for permanent pavements, $20,000 for resurfacing brick pavements and $40,000 for sewers."

Cheyenne, Wyo.

E. W. Glafcke, City Engineer, and Water Commissioner, writes:

"This city is figuring on the laying of about 5,000 ft. of 4, 6 and 8-in. cast iron pipe. This will be an extension to our present system and will provide water for new additions recently made to the city.

"On account of the great demand for houses for renting and home purposes meetings have been held by the Industrial Club and other organizations, in which plans have been made for the construction of 30 to 40 residence and apartment houses to be rented or sold on easy payments. If this is carried through it means further extensions of water and sewer service.

"A report has been made by this department on the necessity of enlarging our outfall sanitary sewer mains. At present they are carrying about all they were designed to carry. This may bring about the construction of a combined storm and sanitary sewer, large enough to care for all storm and sanitary sewer, large enough to care for all storm waters as well as the sewage of the city for some time to come. Furthermore, the paving proposition has been agitated by the business people, and they are ready to put up the necessary money to pave as soon as storm sewers are constructed. The city and county are constructing a new building at a cost of $200,000, which is expected to be finished in the next six months.

"The Hyand's fireproof business block, costing $250,000, will also be finished by July 1. The Union Pacific Railroad Company is to expend this year $1,500,000 in the construction of new shop buildings, with the expectation of employing 600 additional men. The Colorado & Southern are contemplating the erection of an addition to their new 10-stall roundhouse, and a new shop building at a cost of $75,000. Purchases have been made by a large number of our people of residence lots, for the purpose of building homes this summer. Consequently the outlook for 1919 is better for all construction work than I have ever seen it here."

Augusta, Ga.

Nisbet Wingfield, who recently resigned his position as City Engineer and Commissioner of Public Works of Augusta, to open an office in that city as Consulting Engineer, writes:

"Before leaving the city I worked out a paving program for the year 1919, which called for the construction of approxi-

mately $300,000 worth of paving on several streets. One-third of this was to be paid by the city out of the general tax fund, and two-thirds by the abutting property owners. Whether or not this program will be carried through in its entirety, I cannot say, but I am satisfied that at least 60,000 yds. of concrete pavement will be put down; in fact, this work is now under way.

"I am very much in sympathy with the movement to inaugurate all construction work possible during the readjustment period. I believe, however, that for several months the amount will be limited on account of the uncertainty as to prices of material and labor; many municipalities as well as individuals are purposely delaying work with the hope that both labor and material will decline in cost. If the looked for decline does not occur several months must elapse before it is recognized that the present prices are stable.

"My own opinion is that prices will gradually decline for two or three years and I believe that the public generally will soon realize the fact that nothing material is to be gained by putting off improvements indefinitely."

Albuquerque, N. M.

C. B. Beyer, Acting City Engineer, writes:

"Our interest at this time centers chiefly upon the paving question, and we have under consideration a tentative project of some twelve miles, to include the more important thoroughfares of the city, involving an expenditure in the neighborhood of $350,000. Preliminary surveys and gathering of cost data are now under way, but no real action has been taken in the matter as yet. However, we hope to see dirt flying upon part of this project at least before next fall.

"A city plan is another of our proposed undertakings for the year. Should Albuquerque adopt such a plan, the data and other necessary information will doubtless be worked out in conjunction with our paving program.

"Should the above plans not materialize, our actual work will, owing to the city's financial status, be confined necessarily to maintenance of present equipment. Several minor projects, however, will be undertaken at the very earliest possible moment, including: Partial reconstruction of Coal avenue viaduct; three new wooden bridges, and co-operation with Bernalillo county in establishing Rio Grande Park.

"From present indications Albuquerque is scheduled to witness the greatest era of building in its history. Lack of modern residences and buildings has made itself evident, and the outlook is exceptionally cheerful.

"We are heartily in accord with the 'employment to service men' idea and have put our belief into actual execution. Every department head under this administration believes Uncle Sam's men deserve first consideration in the post-war adjustments, and that's what they will receive here."

Street Department, Worcester, Mass.

J. C. Blake, Street Commissioner, writes:

"We are contemplating doing quite an amount of work during the year 1919, not only in the way of paving, but in construction and maintenance as well. Previous to the signing of the armistice we had been called upon by the United States Government to give an approximation of the amount of work and kind of work we intended doing during 1919. After the armistice was signed, as you well know, the ban was raised, and it made a complete change in our program for this year.

"We expect to spend during 1919 in paving about $125,000, but are unable at the present time to give you any particular location where this amount of money will be expended.

"In construction (making private streets public and constructing same), we expect to do the widening of Belmont Hill, which fills in the break from the new Lake Quinsigamond bridge to Shrewsbury street. This will call for an expenditure of about $150,000 in a special appropriation. We are undecided at the present time just what we will use in the construction of the hill, in the way of paving. We are also contemplating constructing that portion of Park avenue between Mill and Stafford streets, which, if done, will mean quite a little construction job. This would mean probably an expenditure of $200,000 in construction, altogether.

"We also expect to do quite a little macadam paving, but we are wholly in the air on this amount at present, owing to the fact that the City Council has not passed any orders for this kind of work as yet.

"We expect to do quite a good deal of maintenance work in the way of Topeka Top: Lincoln street, 9,600 yds.; Southbridge street, 9,000 yds.; Salisbury street, 12,000 yds., and a few other minor streets that may be done during the year."

Ft. Wayne, Ind.

F. M. Randall, City Engineer, returns the following report:

"Pavements, $250,000; bridges, $5,000; water works, $200,000; sewers, $10,000. Much more in sight."

Cincinnati, Ohio

F. S. Krug, Chief Engineer, gives the following list of proposed street and sewer improvements. He advises that these improvements either are under contract or about to be let, and the bulk of the work will be done during the present year.

STREETS UNDER CONTRACT

	Yardage		Cost
Eastern Avenue	13,600	Granite	$106,972.00
Freeman Avenue	17,600	Granite	104,221.00
Central Avenue	22,700	Wood Block	151,765.00
Madison Road	61,700	Bit. & Brick	309,236.40

PROPOSED STREET CONTRACTS

Harrison Avenue	14,200	Granite	87,965.50
Hamilton Avenue	21,500	Brick	90,000.00
Jones Street	2,900	Bitulithic	20,352.50
Grand Vista Avenue	1,650	Concrete	5,684.00
Elsinore Place	1,400	Bit. Macadam	6,339.50
Haven Street	2,460	Concrete	14,893.50
Turrill Street	3,000	Asphalt	19,169.50
Verdin Aveune	3,350	Brick	16,989.84
Verne Avenue	4,050	Brick	22,000.00
Davey Avenue	1,950	Bit. Macadam	7,500.00
Davoran Street	820	Concrete	5,000.00
Minion Avenue	2,750	Concrete	12,500.00
Gilsey Avenue	1,750	Bit. Macadam	10,000.00
			$990,588.74

SEWERS UNDER CONTRACT

	Length		Cost
Rulison Ave., etc.	6,235 ft.	8 in.—22 in.	34,150.00
Paxton Avenue	4,677 ft.	15 in.—93 in.	41,908.00

PROPOSED SEWER CONTRACTS

Gladstone Avenue No. 1	2,020 ft.	12 in.—18 in.	11,080.00
Ballard Avenue	1,635 ft.	27 in.	26,910.00
Clifton Avenue	420 ft.	22 in.	7,500.00
Gladstone Avenue No. 2	2,100 ft.	12 in.—15 in.	12,500.00
Ravine S. of Ridgeway Ave.	1,825 ft.	30 in.—48 in.	22,000.00
Highland Avenue	845 ft.	12 in.—22 in.	8,500.00
Madisonville No. 4	54,265 ft.	8 in.—48 in.	330,000.00
Mill Creek	19,896 ft.	8 in.—87 in.	870,000.00
			$1,364,548.00

Oak Park, Ill.

W. F. Sargent, Commissioner of Public Works, submits a statement showing what Oak Park contemplates in the way of street pavements and other public improvements during 1919. Only the summary is here given.

In addition to this Oak Park has tentative plans for improving about two miles of street in addition to that noted herewith:

Item			Cost
Street pavements	Contract let, sq. yds.	6,878	$27,810.00
Street pavements	Pending in court, sq. yds.	25,064	89,536.00
Street pavements	Contemplated, sq. yds.	81,123	361,992.00
Alley pavements	Pending in court, sq. yds.	5,604	14,054.90
Sewers	Contemplated, sq. yds.		11,833.00
Total		118,669	$505,225.90

Davenport, Iowa

The Board of Public Works is asking outside contractors to bid on a big program of street paving on Feb. 18, until 2 p. m. Bids are to be on asphaltic concrete, brick or bitulithic, on 63 systems of streets. The total estimated cost is about $851,000. Hugo Moeller is city clerk. Harry W. Phillips, Commissioner of Public Works, and Roscoe Sawistowsky is City Engineer.

Jersey City, N. J.

C. A. Van Keuren, Chief Engineer, Department of Streets and Public Improvements, states that estimates have been prepared for paving to cost $1,400,000. The total yardage is 363,810. The work comprises new construction and resurfacing with all the standard types of materials.

Los Angeles, Calif.

W. T. Knowlton, Engineer of Sewers, reports much prospective sewer work, aggregating 443,123 ft. of sewer. The length for various sizes follows: 6 in., 48,770; 8 in., 161,511; 10 in., 21,900; 12 in., 10,900; 15 in., 5,692; 18 in., 13,700; 21 and 24 in., 5,550 ft.

Astoria, Ore.

R. A. McClanathan, Deputy City Engineer, reports the following work to be done this year:

Building sea wall and filling tide flats	$400,000
Street improvements, grading and paving	150,000
Sewers, reinforced concrete and tile	100,000

Board of Local Improvements, City of Chicago

M. J. Faherty, President of the Board of Local Improvements, sends us a letter to him from James T. Igoe, city clerk, and answers to this letter from Sewer Engineer C. D. Hill, Chief Street Engineer J. G. Gabelman, and Superintendent of Sidewalks N. E. Murray.

The letter from Mr. Igoe to Mr. Faherty follows:

"At a meeting of the Committee on Streets and Alleys, held Wednesday, Jan. 15, 1919, I was directed to request you to supply the following data and any other information which will throw light upon the objects discussed by said committee relative to public improvements:

"1. The amount of paving, sewer and sidewalk construction which the board intends to begin and finish this year.

"2. The amount of such work which will be ready when the construction season opens.

"3. The amount of such work which will be ready by June 1.

"4. The amount of such work which you intend to start after the last named date.

"5. The amount of work which you will have on Feb. 1, on which you will then be ready to award contracts.

"6. The same information in regard to other improvements under the jurisdiction of the board.

"7. Your opinion on whether the above program should be increased, and the extent to which it should be boosted, together with the reasons therefor.

"8. The board's program for supplying work during the period of demobilization.

"9. The difficulties in detail to the carrying out of a construction program during 1919 of twice the size of your largest construction year.

"10. Any other suggestions and information you deem pertinent."

The answers to Mr. Igoe's questions as returned by Mr. Hill, Sewer Engineer, follow:

"1. We expect to begin and finish sewer construction to the amount of $700,000 during the present year.

"2. Of such work about $400,000 is the amount that will be ready when the season opens.

"3. Of such work about $500,000 is the amount that will be ready by June 1.

"4. Subsequent to June 1 we expect to let contracts to the amount of about $200,000.

"5. About $400,000 is the amount of work that will be ready for awarding contracts on Feb. 1.

"6. This department has a large program of street openings, which, however, will not result in any considerable amount of construction work during the present year.

"7. In my opinion the board should push proceedings for local improvements where the property owners can afford to pay the cost.

"8. The board has no program other than starting proceedings for local improvements and carrying the same through to completion.

"9. The principal difficulty in carrying out of construction program during 1919 of twice the size of our largest construction year is in getting property owners to consent to assessments, which must necessarily be very high. Much of the real estate of the city is in condition that makes any special assessment oppressive.

"10. I believe that one kind of improvement that is urgent and that involves only light assessment on property benefited is the construction of large relief sewers. These sewers are urgently needed, and as a rule the assessment would be but slightly above $1.00 a front foot on the property benefited."

The answers of Mr. Gabelman to the questions follow:

"1. The amount of paving work which we will probably begin and finish this year I estimate to be about 1,900,000 sq. yds. This, of course, depends on how fast the courts work in confirming assessments, and also on whether estimates are stayed at publish hearings, Council, etc.

"2. The amount of paving work which will be ready when the construction season opens will be about 770,000 sq. yds.

"3. By June 1, 250,000 sq. yds. more or about 1,020,000 sq. yds. will be ready.

"4. The amount of work which we intend to start after June 1 will be about 950,000 sq. yds. Some of this work will probably not be completed this year, depending somewhat on the condition of the weather late in the fall.

"5. The amount of work which we will have ready on Feb. 1 will be 384,500 sq. yds.

"6. This does not apply as to street paving.

"7. In my opinion the above program should be increased to about twice the present amount. My reasons therefor are that there are many streets in the city which are not paved which should be paved on account of traffic conditions. Other streets and alleys should be paved on account of the comfort and health of the general public, and for fire protection.

"8. This division is making every effort to hurry its work along so that we may aid in supplying the work during the period of demobilization.

"9. The difficulties in detail to the carrying out of a construction program during 1919 of twice the size of the largest construction year are principally lack of funds, as a larger force would have to be employed, and the fact that orders are not in at this time for enough work to carry out a program of twice the size of our largest construction year. We could, however, increase our program materially if an effort were made by the Council and the Board at this time to order the improvement of more streets and alleys.

"10. There are pending in the Council at the present time as referred, deferred or filed, proceedings for streets amounting to 500,800 sq. yds., and 36 alleys amounting to approximately 36,000 sq. yds., or a total of 536,800 sq. yds. If the Council will pass the ordinances for these streets and alleys they will aid materially in increasing the amount of work done in this department during 1919. I understand a large number of these proceedings are in the hands of the Committee on Home Defense."

N. E. Murray, Superintendent of Sidewalks, reports proceedings for sidewalks as follows:

"1. Projected improvements in course of preparation for ordinances on 1,929 streets, totaling 435.49 miles.

"2. Ordinances passed on which assessment rolls have not been filed on 591 streets, totaling 133.42 miles.

"3. Assessment rolls filed in court and not yet confirmed on 215 streets, totaling 48.52 miles.

"4. Assessments confirmed on which contracts can be let whenever ordered, on 900 streets, totaling 203.18 miles.

"5. Contracts let, work not done on 117 streets, totaling 26.49 miles. Total, 1,047.10 miles.

"The only work that is likely to be done this year under Class 1 will be such ordinances as are passed under special taxation.

"The amount of work that can be done under Class 2 will depend entirely upon when the assessment rolls are filed and confirmation obtained.

"There is no reason why all the work under Classes 3, 4 and 5, totaling 278.19 miles, cannot be done this year, if the City Council provides a sufficient number of inspectors and engineers to look after the work. Based on present prices, the cost of work in Classes 1 to 5, inclusive, will be approximately $6,000,000."

Twenty-five State Highway Engineers Report Their Plans for 1919

Letters follow from twenty-five engineers of as many state highway commissions, giving their plans for the coming construction season in some detail. These letters to the editor are fairly representative of conditions throughout the country. That this is to be a great year for highway workers no one can doubt who will read these letters.

Colorado

J. E. Maloney, Chief Engineer, State Highway Commission, Denver, gives the following general facts concerning proposed road expenditures in Colorado in 1919:

"The total State fund available will be $1,000,000. The counties will have available from their direct tax levy, for roads and bridges, $2,000,000. There will be available from the United States, Federal Aid amounting to $320,000. The counties will contribute about $500,000 from the County Road fund for the maintenance and construction work on the State Highway system. This will make available for the State Highway system a total of $1,800,000 from all sources. The State Highway system comprises 7,200 miles of road; while the County Road system would be 35,000 miles. Upon the State system, the maintenance of present mileage of road including repairs to bridges and culverts, will take about one-half of this total fund; the balance being devoted particularly to improvements, re-locations, and new constructions of roads and bridges.

"The Commission has authorized the construction of 11 miles of hard surfaced road pavement in short stretches from ½ to 2 miles in length in the vicinity of the following cities: Denver, Greeley, Boulder, Longmont, Sterling, Fort Morgan, Colorado Springs, Pueblo, Rocky Ford, La Junta, Delta, Montrose and Grand Junction; this work contemplates an expenditure of about $250,000. Ninety thousand dollars will be expended upon the improvement of the Big Thompson Canon Road in Estes Park and $60,000 upon the completion of the Fall River Road above Estes Park in the Rocky Mountain National Park.

"It is estimated that $350,000 will be expended on the great North and South Highway, south from Pueblo to the New Mexico Line; this improvement will include surfacing and construction of bridges.

"Additional construction work will be done at the following points near Wray, Lamar, Fort Collins, Ouray, Blue River Road, San Miguel County near Craig and in Eagle County. The estimated costs of these various pieces being about $125,000. In addition to this work, the County Road fund will be used to some extent in the construction of new work and bridges on the County Highways of the State, details of which we have not at present in our possession."

Connecticut

Charles J. Bennett, State Highway Commissioner, Hartford, gives this brief summary of highway construction work to be undertaken in Connecticut in 1919:

"We are planning to spend during the coming season approximately $4,000,000 for highway construction purposes, this work to be done in the construction and maintenance of highways and bridges. Possibly we will be unable to spend the entire sum, but we are going at the work with an idea of carrying on a very busy campaign for the improvement of highways in this State. Certainly, I believe that now is the time to build up our highway systems.

"I hope for slight reductions in the price of labor and materials which will allow us to carry forward this work."

Delaware

Charles M. Upham, Chief Engineer, State Highway Department, Dover, advises that there is approximately $1,300,000 in contracts left over from 1918. His letter continues:

"The first step in our program for 1919 will comprise approximately 51 miles of roadway in different parts of the state. This will be let at different times during the early part of the year. As soon as this work is under contract and if the material and labor supply is then adequate, a supplementary program will be undertaken which will comprise approximately the same amount of work as the first part of the 1919 program. The contracts will range in length from ½ mile to 10 miles, so there will be opportunity for contractors with different sized plants and equipment.

"Besides the State program for 1919 it is expected that there will be considerable County work carried on. At the present time there is available for the County program, bond issues to the amount of $1,000,000.

"Road work in Delaware was put on a firm foundation with the creation of the State Highway Department, and the first year's program was seriously impeded by the conditions that prevailed during the time our country was at war, but with the reconstruction period about to commence, it is expected that Delaware will quickly construct her highways and carry on a large program."

Georgia

W. R. Neel, State Highway Engineer, Atlanta, writes:

"We have no idea just what will be the amount spent on road construction in Georgia this year, but I am sure it will be our biggest year by far.

"The usual three or four million dollars spent by counties is assured and there are also several bond issues now being agitated, aggregating about four millions more.

"The Highway Department has proposed the increase of the automobile license fee and requested a Constitutional amendment which will allow the State to issue bonds to be retired with this proposed increased automobile fee.

"This seems to meet with unanimous approval and will, I think, become a law shortly after the General Assembly meets this June.

"What I am striving for is action *now* in order to give employment to everyone needing it."

Illinois

Clifford Older, Chief Highway Engineer, Springfield, writes:

"The construction program to be undertaken by this state this coming season will depend to a considerable extent upon conditions governing the final cost of the roads.

"Among such conditions might be mentioned: The possible reduction of freight rates. The availability and cost of labor. The availability and cost of materials.

"Granting that these conditions will be satisfactory, it will be possible for Illinois to spend:

"About $2,000,000 on state aid road construction, for which funds were appropriated by the state legislature and the several counties of the state in 1917.

"About $4,500,000 of state and federal funds on federal aid roads.

"About $2,000,000 of county funds on federal aid roads.

"In addition the people of several counties of the state have approved bond issues for the construction of roads other than those included in the above. Such county bond issues amount to several million dollars.

"We expect to have completed surveys, plans and specifications for five hundred miles or more of road by early spring. The validity of the bond issue act will be tested in the Supreme Court of the state, and at the present time it seems possible that a decision may not be rendered until June. This, therefore, may effect the total amount of construction that may be undertaken in this state during 1919."

Kansas

M. W. Watson, acting State Highway Engineer, Topeka, writes:

"Up until a short time back, Kansas has been classed in road work as one of the most dilatory states in the Union. She has been a leader in practically every other reform or progressive movement and her apparent lack of interest in the construction of hard surfaced roads is not entirely due to her backwardness, but partially to the fact that naturally we have the best earth roads in the country. The people are now beginning to realize that even as good as they are, an earth road is inadequate for modern traffic.

"Our worst difficulty is from the dry weather in the semi-arid regions of western Kansas, where the soil is very light and during extreme dry weather, the soil becomes dusty and the high winds blow away the roads until they are considerably below the surrounding country.

"The legislature of 1917 provided the ammunition by which we could start a very progressive road movement, creating the State Highway Department and providing for the accepting of Federal aid and the construction of roads under the benefit district road plan. Since that time, the State Highway Commission has received applications for Federal aid covering 34 sections of highway of which 31 have been allowed and three rejected by the department.

"We have presented to the Federal Government applications for Federal aid on 22 projects, of which two have been rejected and two have not yet been acted upon by the Government.

"The entire amount of work upon which preliminary steps have been completed amounts to 344.7 miles, at an approximate estimated cost of $10,163,930. The State Highway Commission is giving to the counties 25% Federal aid and on this basis we have already filed sufficient applications to absorb the entire allotment of aid to Kansas under the present Federal aid appropriations.

"Shortly after the organization of the State Highway Commission, the war came on, which prevented any extensive road improvement, so that we have at the present time only one contract under way, which was of war necessity and extended from Junction City, Kansas, to Fort Riley and Camp Funston. This road is 1.118 miles in length and for the greater portion consists of a 20 ft. monolithic brick road, 240 ft. being of reinforced concrete over a high fill. The brick portion of this road is now completed, but the concrete portion has been held up due to a delay in the construction of a Government bridge over the Republican River.

"Bids were received on January 3d for 27.35 miles of monolithic brick road and the lowest bid received was $1,447,000. Owing to the extreme cost of the road, the county board felt it necessary to reject all bids and it may be that the type and width of this road will be changed and readvertised at some future date.

"You can see from the amount of work lined up for Federal aid that unless the excessive prices deter the board of county commissioners from awarding contracts that Kansas will have an era of road construction during 1919 which will be greater than we will be able to handle with the force of engineers obtainable at the present time. This proposed work is divided between brick, concrete, bituminous macadam, water bound macadam and gravel. The greater portion petitioned for is concrete and brick, which seem to stand in about equal favor.

"In addition to the Federal aid work, there have been petitions approved by boards of county commissioners on other than Federal aid work which will amount to somewhere in the neighborhood of $2,000,000.

"The State of Kansas, although in the past backward in road work, is now coming very rapidly to the front and within a very short period of time will be near the head of the list."

Maine

Paul D. Sargent, Chief Engineer, State Highway Commission, Augusta, writes:

"Funds now available for state highway work in Maine for 1919 are as follows:

Appropriation for state highways.....	$377,000
Federal aid arranged for and contracts outstanding and work in progress.....	200,000
Federal aid apportionment of January 7, 1919, for fiscal year ending June 30, 1920	192,000

"It thus appears that we have not sufficient state highway appropriation to take advantage of all federal aid that will be available during this year, but the Legislature now in session is giving consideration to the question of providing more funds for this work.

"Our regular appropriation for state aid work is $500,000 per year, which will undoubtedly be provided by this Legislature. Cities and towns furnish about $300,000 to go with this, and we have some $250,000 of state aid funds accruing from the last two years which have been unexpended on account of labor shortage.

"We shall have an appropriation of $100,000 of state aid for bridges, and this calls for appropriations by counties and towns of $400,000 to go with it, making possible the construction of $500,000 worth of bridges.

"We have estimated that the requirements for maintenance of state and state aid highways will be $800,000 for the year 1919, of which the towns and cities will furnish $200,000, and the state has been asked to grant $600,000.

"The above briefly outlines the activities of the state of Maine with respect to construction and maintenance of improved highways and bridges during the year 1919."

Massachusetts

Arthur W. Dean, Chief Engineer, Massachusetts Highway Commission, Boston, writes:

"We will have a considerable amount of money available for construction work this year by appropriations in previous years. The regular 1919 appropriations, however, have not yet been made by the Legislature, consequently, I cannot give you positive figures showing just what we will expend this year. We hope and expect, however, that we may have available for expenditure this year a sum equal approximately to $4,600,000 of State funds. The expenditure of this money will be divided as follows: For construction, $1,900,000; for maintenance and reconstruction, $2,700,000. In addition to these amounts, it is estimated that there will be expended, under the direction of this Commission, from $300,000 to $400,000 contributed by cities and towns, and from $100,000 to $200,000 contributed by counties. Of course, the above figures do not include expenditures by cities and towns on their own roads, which is estimated to be about $14,000,000 in a year, but in this expenditure the cities and towns are entirely independent of the State.

"Indications at the present time seem to be that in this State at least there will be plenty of labor and material available for early and continuous work through the season, although it is not expected that the prices of same will decrease much below the prices of 1918."

Mississippi

Xavier A. Kramer, State Highway Engineer, Jackson, writes:

"There is available in the various county and separate road district treasuries, approximately the sum of $3,000,000, which will be used for construction of improved roads during

this year. The work will consist largely of gravel surfaced roads.

"In addition to the above amount, bond issues for approximately $1,000,000 are contemplated and in addition thereto, there is available approximately $500,000 of federal aid.

"Prices for road work are yet very high and labor is very scarce. This department is recommending that the letting of contracts be deferred until spring.

"The construction of roads in Mississippi is largely done by means of teams, and the high cost of feed makes this feature expensive.

"The most important project under consideration is the construction of a bridge across Bay St. Louis on the old Spanish trail road. The estimated cost of this is $750,000. The State Highway Department is now engaged in making the preliminary plans for this structure and the estimates will be submitted to the local county officials within the next 60 days."

Nebraska

George E. Johnson, State Engineer, Lincoln, gives the following summary of proposed road work in Nebraska in 1919:

"We have attempted a plan which embraces 752.91 miles at an estimated cost of $165,789.07 plus $737,663.86 Federal Aid Fund, as follows:

Project Names	Counties	Length	Estimated Cost	Approximate Amt. of Federal Aid
North Platte-Sutherland	Lincoln	19.2	$43,027.97	$21,513.99
Stapleton-Ringgold	McPherson-Logan	17.1	36,216.92	18,108.46
Washington-Burt	Washington-Burt	26.3	56,331.88	28,165.94
Cedar-Wayne	Cedar-Wayne	38.2	105,676.78	52,838.39
Norfolk-Columbus	Madison-Platte	48.1	104,455.50	52,227.75
Kearney-Pleasanton	Buffalo	16.5	33,556.10	19,278.05
Litchfield-Broken Bow	Custer	35.0	74,873.70	37,436.85
Lincoln-Beatrice	Lancaster-Gage	17.95	98,615.00	25,805.64
Fremont-Ceresco	Dodge-Saunders	33.67	50,050.00	25,025.00
Seward-Aurora	Seward, York and Hamilton	50.85	103,007.57	44,861.57
Nebraska City-Plattsmouth	Otoe-Cass	27.55	57,750.00	28,875.00
West Emerald	Lancaster	4.00	19,250.00	9,625.00
Fremont-Ames	Dodge	5.94	140,000.00	18,000.00
Alliance-Antioch	Box Butte-Sheridan	14.83	96,743.79	38,635.303
Harrison-Whitney	Sioux-Dawes	40.8	67,876.85	33,938.42
Douglas County-Lincoln	Douglas	27.00	45,000.00	23,500.00
Hamlet-Imperial	Hayes-Chase	16.8	36,465.00	18,232.50
Sargent-Harrop	Custer-Loup	20.0	27,460.88	13,730.44
St. Paul-Grand Island	Howard-Hall	17.0	27,376.20	13,688.10
Genoa-Albion	Nance-Boone	34.0	42,500.00	21,250.00
Curtis-Stockville	Frontier	21.9	32,218.63	16,109 31
Allen-Ponca	Dixon	17.0	26,070.00	13,035.00
O'Neill-Butte	Holt-Boyd	41.8	83,875.00	41,937.50
Osceola-David City	Polk-Butler	26.9	66,678.14	33,339.07
		16.5		
Schuyler-Columbus	Colfax-Platte—Colfax Platte	10.6	20,000.00	10,000.00
		5.9		
Cambridge-Oxford	Furnas	32.5	34,283.00	17,141.50
Beatrice-Fairbury	Gage-Jefferson	31.12	54,972.50	27,486.25
Bloomington-Orleans	Franklin-Harlan—Franklin, 8.5; Harlan, 15.0	23.5	42,643.70	21,321.85
Rockville-Loup City	Sherman	25.3	25,113.96	12,556.98
	Totals	752.91	$1,657,089.07	$737,663.86

Montana

Paul D. Pratt, Chief Engineer, Helena, writes as follows of Montana's 1919 Highway construction program:

"It is anticipated approximately $1,500,000 will be expended on all highway projects during the 1919 season.

"On the Yellowstone Trail the main east and west highway, the principal tourist route to the Yellowstone National Park and across the state, the following projects are proposed:

"Elimination of dangerous grades on so-called Shirley Hills east of Miles City. (State Aid). Providing drainage and placing compact gravel surface on seven miles of road between Miles City and Tussler. (State Aid). Eliminating precipitous grades and narrow embankments west of Fort Keogh. (State Aid). Placing a compact gravel surface on four miles east of Forsyth. (Federal Aid). Replacing Huntley Bridge and river control at Huntley, which will permit use of main Yellowstone Trail and make it unnecessary to continue detouring over the dangerous road now travelled south of the river. (Federal Aid). Construction of a 270 ft. concrete bridge over Yellowstone River south of Livingston on the branch to the Yellowstone National Park. Replaces steel structure carried away by the high waters of June, 1918. (Federal Aid). Draining and placing compact gravel surface on three projects totaling approximately 11 miles between Livingston and the Yellowstone National Park. (Federal Aid). Paving three sections of Yellowstone Trail west of Bozeman in Gallatin County. (Federal and State Aid). Surfacing 3.3 miles of so-called Cardwell-Nigger Hollow Road, Jefferson County. (Federal Aid). Relocating, reshaping and graveling Deer Lodge to Nimrod Road, in Powell and Granite Counties. Improvement modifies grades and eliminates the dangerous Nimrod Hill. (State Aid). Relocating and reconstructing road and eliminating so-called Marshall Grade in Missoula County. (Federal Aid).

"Proposed expenditures on Red Trail east of its confluence with the Yellowstone Trail at Terry: Grading, drainage and surfacing four projects in Wibaux County, approximately 17 miles. (Federal Aid). Providing drainage, grading and surfacing 28 miles in vicinity of Glendive.

"At the present time there is no trans-state highway in northern Montana. The Highway Commission has designated certain roads for improvement and located the missing section over the Continental Divide between Glacier Park Station and Belton. Work has been started in Lincoln, Flathead, Blaine, Phillips and Valley Counties, which, when completed, will link with and form part of this northern Montana trans-state route. Work on all these projects will go forward during the coming season.

"In addition to the foregoing, there are approximately 40 projects, Federal and State Aid, on auxiliary or market highways of the state, construction of which will be undertaken as quickly as attending conditions permit."

New Jersey

W. G. Thompson, State Highway Engineer, Trenton, writes:

"Since we have not as yet received any requests from the counties of the State, we do not know how much work they intend doing, but anticipate a general resumption of highway construction and maintenance on a scale never before attempted. Including the work contracted for in 1918 and which was stopped by the restrictions of the United States Highway Council, the State Highway Department of New Jersey expects to construct during the season of 1919 approximately 100 miles of State Highways, at a total cost of approximately $5,250,000. In addition to this amount, the State will give as aid to the counties, approximately $2,000,000 toward the repair, maintenance and reconstruction of county roads, approximately $500,-

000 as aid to the counties for new construction of county highways, and $105,000 to the townships for the improvement of township roads.

"It is assumed the counties of the State will spend during the coming season approximately $3,000,000 for repairs, maintenance, and reconstruction, and new construction, in addition to the amounts allotted by the State. It will be seen, therefore, that providing able contractors and materials are available, there will be under way by the middle of the coming construction season approximately $9,000,000 worth of work in the State of New Jersey. It is expected this will be one of the busiest years that New Jersey has ever experienced with reference to highway improvement."

North Dakota

J. E. Kaulfuss, Assistant Chief Engineer, North Dakota State Highway Commission, Bismarck, writes:

"Plans have been drawn and we are ready to advertise for approximately 200 miles of new work, earth and gravel roads, amounting to nearly $350,000.

"In addition we have made surveys and are drawing plans for work to be let, if that is possible, this year, depending upon the available contractors in the state and upon the state's activity as to day labor work, for approximately 325 miles of construction similar to the above, amounting to $550,000.

"In spite of the abnormal conditions of 1918 the department was able to place about 250 miles under construction, costing about $325,000. Fifty per cent. of this work, perhaps, was completed. The remainder is to be finished at the earliest possible time this spring.

"In other words, we have in sight for 1919, 650 miles of state highway work, principally federal aid construction and earth roads, which amounts to a trifle over $1,000,000. Just how much of this we can do will depend upon two factors as previously stated, first, the number of contractors available to do this work, and second, the development of a day labor scheme, the work to be done by the counties and the state.

"We are not attempting to give you any figures on strictly county, township or municipal road and bridge work, but it is believed that not less than $2,500,000 will be spent this year by these governmental units.

Oklahoma

Max L. Cunningham, State Engineer, Oklahoma City, writes:

"It is impossible for us to give at the present time even an estimate of what will be done by this State during the next year. There is pending before the present legislature a large amount of road business, and until they settle this there is no way of even estimating what will be done, although we feel sure that 1919 will be a banner year."

Pennsylvania

William D. Uhler, Chief Engineer, State Highway Department, Harrisburg, writes as follows of the funds available for highway work during the coming season:

State highway construction	$2,900,000.00
State aid construction	1,300,000.00
Federal aid available	1,688,000.00
Estimated receipts of automobile division for the year 1919, to be used in maintenance work	5,000,000.00

"In addition to the above amounts the Legislature which is now in session will make available the proceeds from the $50,000,000.00 bond issue recently voted on in this state. No information is available as to the amount of this bond issue that will be set aside for 1919 work."

Rhode Island

Irving W. Patterson, Chief Engineer, Providence, writes:

"Definite information at this time is impossible because of the fact that our General Assembly which is now in session has to date taken no action in regard to the appropriation of funds for state road work during the ensuing year. There are no certainties at present so that all of the information which it is possible to give you at this time is in the way of reasonable probabilities.

"We have requested our General Assembly to make available $400,000 in addition to the funds received under the provisions of our Motor Vehicle Act, which we estimate will amount to about $350,000. We recommend to our General Assembly further that this total of $750,000 be spent for maintenance and reconstruction. The maintaining and the improving of our present system of state highways is the big problem in Rhode Island. All of our main trunk lines have been built, but a great deal of the old macadam laid many years ago has outlived its usefulness very largely and should be rebuilt.

"In addition to the state funds proper which may be made available for our work there is also to be noted funds due Rhode Island under the terms of the Federal Aid Road Act of 1916. Approximately $35,000 is due Rhode Island for the fiscal year ending June 30, 1919, and approximately $46,600 will be available subsequent to June 30, 1919, for the following fiscal year. State funds equal to the amounts stated are already available under the provisions of an act by our General Assembly, accepting the provisions of the Federal Aid Road Act. The Federal Aid Road fund may therefore be considered to be $163,000, roughly."

South Carolina

R. T. Brown, Assistant State Highway Engineer, Columbia, writes:

"From every viewpoint the indications are that the people of South Carolina have passed the promotional and emotional stage in relation to the importance of good roads. We are settling down now to the consideration of the means wherewith to build really good roads as early as possible.

"At present all road construction in the State is carried on with the county or township as the unit, there being no state roads and no State Aid for construction and maintenance. The State Highway Department licenses motor vehicles, returning 80% of the license fees to the counties from which collected to be spent by them on roads and bridges. The remaining 20% is used to bear the expense of licensing motor vehicles and to maintain an Engineering Department to handle Federal Aid road work.

"The total Federal Aid apportioned to South Carolina from the appropriation of 1916 is $1,077,114.60. The State Highway Commission tentatively allotted this fund by counties on the basis of area, population, assessed valuation, and mileage of proposed state roads, in order to give all counties equal chances to apply for these funds. In case any counties do not apply within a specified time the funds will be allotted on projects in other counties which do apply.

"To date there have been applications made by 29 of the 45 counties. In two counties Federal Aid Projects are practically completed, involving a total cost of about $170,000, of which $65,080.18 is to be paid from Federal Aid. Construction is in progress on two other projects involving $89,223.80, of which $42,751.44 is to be paid from Federal Aid. Seventeen other projects have been approved by the U. S. Secretary of Agriculture, making a total of 29 projects approved to date, the total estimated cost of which is $873,920.67, of which $358,586.83 will be paid from Federal Aid.

"Surveys and plans are practically completed on nineteen projects; so that considerable work can be started as soon as labor becomes available.

"On one porject for the construction of 12.17 miles of sand-clay road, for which bids were requested during 1918, no bid was received. Another project for the construction of 3½ miles of road and bridges thereon has been advertised three times within the past four months without being let. Three

bids were received, all of which were much in excess of the funds available.

"The State Automobile Association has recently inaugurated a campaign for a $25,000,000 bond issue for the construction of hard surfaced roads in the State. It is proposed to pay the interest and to retire the bonds by receipts from the licensing of motor vehicles. The Association has prepared a bill to introduce before the present legislature, authorizing such a bond issue. It appears now, however, that reconnaissance, surveys and estimates will have to be made and the roads to be built designated before the voters will ratify the bond issue. The Highway Department has outlined a proposed system of state highways which comprises more roads than could be built of high type construction with the bond issue proposed. Several of the most important highways, however, could be constructed with this fund, after which those next in importance could be cared for by other means, such as local taxes and bonds and future Federal Aid.

"While South Carolina has heretofore been classed with the most backward states in the matter of improved roads, she is now catching step with the most progressive. Her fertile farming lands and prosperous manufacturing towns and cities when inter-linked with a system of hard surfaced highways will quickly bring her into the position of one of the foremost of Southern States."

South Dakota

Frank S. Peck, Highway Engineer, Pierre, writes:

"Herewith is a list of our Federal and State Aid roads which will be built during 1919, provided the necessary contractors can be secured:

LIST OF PROJECTS APPROVED

	Amount
Codington Co., 11.24 miles, gravel surface	$47,972.10
Lincoln, Co., 10.00 miles, gravel surface	41,553.16
Grant Co., 11.83 miles, earth surface	26,963.39
Brookings Co., 6.5 miles, gravel surface	19,946.30
Minnehaha Co., 25.00 miles, gravel surface	100,608.06
Moody Co., 9.13 miles, gravel and earth	26,774.44
Deuel Co., 8.6 miles, gravel surface	28,943.38
Butte Co., 11.5 miles, earth surface	20,638.20
Brown Co., 12.85 miles, gravel surface	72,424.00
Clark Co., 14.29 miles, gravel surface	44,143.83
Total	$429,966.86

STATE AND FEDERAL AID ROAD PROJECTS UNDER PREPARATION

	Amount
Clay Co., 9.97 miles, gravel surface	$36,502.36
Yankton Co., 10.10 miles, gravel surface	47,304.88
Davison Co., gravel surface	30,388.10
Meade Co., 8.00 miles, earth surface	10,000.00
Roberts Co., 35.00 miles, earth surface	52,126.72
Stanley Co., 15.00 miles, gravel and earth surface	30,294.78
Hanson Co., 7.25 miles, gravel surface	23,880.34
Lawrence Co., 24.00 miles, gravel and earth surface	42,139.52
Pennington Co., 16.00 miles, earth surface	62,065.70
Total	$334,702.40

"We also expect to prepare a number of other prospects during the coming season. Besides this the counties and townships have levies of over $2,000,000 for road construction and maintenance."

Tennessee

A. M. Nelson, State Highway Engineer, Nashville, writes:

"I am sending you herewith a list of projects showing the counties in which they are located, the type of surface and the amount of federal, state and county aid.

"These projects will be advertised and an attempt made to let them and construct this work during the coming season.

"Our greatest difficulty previously has been the unsettled labor conditions and high prices of material, which I hope will be very much modified as the forces from overseas are returned to the United States, many of them will be seeking employment.

"You will note in this tabulation that we have segregated state aid projects from the state and federal projects."

Utah

Ira R. Browning, Engineer, Utah Road Commission, Salt Lake City, gives the following estimate of road work in Utah in 1919:

STATE ROADS

Hard Surface Roads

Ogden to Salt Lake	12 mi., at $20,000 per mi.	$240,000
Midvale Jct. to Utah Co. Line	11.4 mi., at 20,000 per mi.	228,000
Utah Co. Line to American Fork	8.2 mi., at 20,000 per mi.	164,000
Pleasant Grove to Provo	9 mi., at 20,000 per mi.	180,000
Provo to Payson	18 mi., at 20,000 per mi.	360,000
West 33rd, South Street	5 mi., at 20,000 per mi.	100,000
Brigham City to Ogden	16 mi., at 20,000 per mi.	320,000
Logan to Smithfield	6 mi., at 20,000 per mi.	120,000
Logan to Wellsville	7 mi., at 20,000 per mi.	140,000
Price to Helper	6 mi., at 11,000 per mi.	66,000
Total		$1,918,000
Counties' amount		959,000
State's amount		959,000

FEDERAL AID PROJECTS

		Est. cost
Proj. No. 2—Ogden-Hooper	9.25 miles	$61,310
Proj. No. 4—Price-Emery	63.00 miles	109,923
Proj. No. 5—Thompson-Moab	35.00 miles	50,686
Proj. No. 6—Moab-La Sal Junction	24.06 miles	34,755
Total		$256,704
State's amount		128,352
Federal aid		128,352
Total amount state	$1,087,352	
Total federal aid	128,352	
Total amount counties	959,000	
Grand total	$2,174,704	

Virginia

G. P. Coleman, Commissioner, State Highway Commission, Richmond, writes:

"During the past 18 months, owing to unusual conditions brought about by the war, as well as to the peculiar situation of Virginia in regard to government shipments of materials, we were unable to carry out any of our general plans for highway construction. As a matter of fact, transportation difficulties made even ordinary maintenance in many instances out of the question.

"As far as possible, however, during this period we prepared our plans to resume work as soon as possible after peace, for we have always been imbued with the idea that with the coming of peace, would also come the greatest road era the world has ever known, and with it the development of the untold resources of this country.

TENNESSEE FEDERAL AID PROJECTS

Project No.	State Highway No.	County	Type of Surface	Federal Aid	State Aid	County Aid	Total
1	20	Hamilton	Concrete	$25,937.07	$14,062.93	$14,737.67	$54,737.67
2	7	Hamilton	Macadam	18,454.84	1,545.16	16,909.69	36,909.69
3	7	Franklin	Macadam	40,000.00	53,000.00	28,474.44	121,474.44
4	7	Bedford & Moore	Gravel	49,737.38	24,711.54	25,025.84	99,474.76
5	2	Greene	Macadam	19,160.95	5,839.05	13,321.91	38,321.91
6	2	Washington	Macadam	143,854.82		143,854.82	287,709.64
7	11	Henry	Chert	65,000.00		65,000.00	130,000.00
8	1	Hawkins	Macadam	150,000.00		200,000.00	350,000.00
8	1	Grainger	Macadam	12,500.00	12,500.00	40,000.00	65,000.00
8	1	Sullivan	Macadam	12,500.00	12,500.00		25,000.00
9	3	Carroll	Chert	60,000.00		60,000.00	120,000.00
			Total	$597,145.06	$124,158.68	$607,324.37	$1,328,628.11

TENNESSEE STATE AID PROJECTS

Project No.	State Highway No.	County	Type of Surface	State Aid	Private Subscription	Total
1	7	Coffee	Chert	$28,533.30	$10,000.00	$38,533.30
2	1 & 10	Maury	Chert	25,000.00	6,620.00	31,620.00
3	7	Marion		25,000.00		25,000.00
4	Flag Pond	Unicoi	Macadam	25,000.00		25,000.00
			Total	$103,533.30	$16,620.00	$120,153.30

"We have for the construction of the State Highway System for the coming year approximately $2,000,000, and for maintenance and reconstruction of state highways approximately $750,000. For new construction on county highways, under the State Aid plan, there is approximately $1,000,000. Appropriations for maintenance of county highways have not as yet been made, but will aggregate approximately $1,200,000.

"General plans are well under way for a special 1½ mill tax for construction purposes on the State Highway System. We believe this plan will materialize and make available from all state and federal sources between $4,500,000 and $5,000,000 annually. The advisability of issuing $25,000,000 of bonds is also receiving very careful consideration.

"Virginia is fully alive to the necessity for and the importance of a broad and comprehensive highway policy, and what is very much more to the point, her citizens are back of the program for the immediate development of such a policy."

Washington

George F. Cotterill, Chief Engineer, Olympia, writes:

"I am giving herewith an estimate of the 1919 road program for the State of Washington, covering both construction and maintenance of the state and county highway systems outside the limits of the incorporated cities.

"By reason of the postponed work and funds held over from last year with the new funds available in 1919 it would appear that there will be about $12,000,000 available from Federal Aid, state, county and district funds. The State Legislature has just assembled and in the various plans for the reconstruction period it is certain that all these funds and perhaps some increased resources will be made available for an extensive highway construction program to open as soon as seasonal construction conditions will permit.

Federal Funds: (Post Roads and National Forest Roads)	$825,000
State Funds: (Public Highway, Permanent Hwy., Motor Licenses)	4,175,000
County Funds: 39 Counties: (County Road & Bridge, Road Districts, Special Imp. Districts, County Bonds)	7,000,000
Total	$12,000,000
New Construction program for 1919:	
Federal Administration: National Forest Roads..	$500,000
State Highway Department: Federal Aid Post Roads and State Highways	2,000,000
County Administrations: Permanent Highways and other Main County Highways; District Roads, Bond Roads	5,500,000
Total New Construction for 1919	$8,000,000
Maintenance program for 1919:	
County Administrations (under State Regulation): 2,000 miles of Primary State Highways	$750,000
County Administrations: 1,000 miles County Permanent Highways, etc	250,000
40,000 miles Tributary, Local, District Roads	3,000,000
Total Maintenance for 1919	$4,000,000
Total 1919 Program—Construction and Maintenance.	$12,000,000

West Virginia

A. Dennis Williams, Engineer-Chairman, Charleston, writes:

"Highway construction in 1919 in West Virginia calls for the utilization of sixteen million of funds now available and indications are that three to four million more will be voted this spring in various counties and districts."

Wisconsin

H. J. Knelling, Assistant Engineer, Madison, writes:

"Our plans for 1919 call for about $3,200,000 worth of Federal Aid construction. This is made up of about $1,029,000 for grading only on 238 miles of road, of $1,088,000 for graveling or macadaming 153 miles of road, and $1,095,000 for concreting 52 miles of road.

"In addition to this we have about a similar quantity of money for our so-called State Aid construction in which the Federal Government is not a party. Just how this is divided regarding funds and mileage we are unable to state, but it will run about the same as the Federal work."

Wyoming

Z. E. Sevison, State Highway Engineer, Cheyenne, writes:

"We expect to construct roads costing about $700,000. This is the work which will be undertaken by the State Highway Department and does not include expenditures by the counties which will probably total $500,000 more."

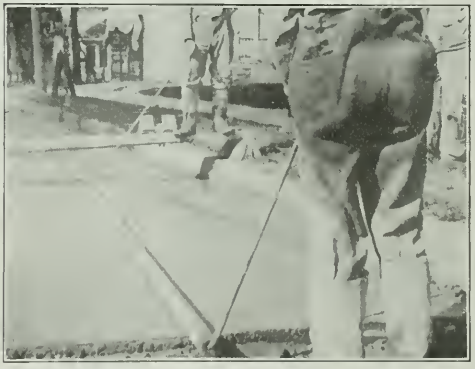
Method Employed in Minneapolis in Constructing Smooth Surfaced Concrete Base for Wood Block Paving

By Ellis R. Dutton, Assistant City Engineer Minneapolis, Minn.

Being convinced by observation and also by theory that the laying of creosoted wood block paving on a smooth top concrete with a bituminous cushion was the best method of construction, we began to lay this class of paving that way in the season of 1918, in the city of Minneapolis.

Difficulty of Getting Smooth Base

The only objection we have had as to this way of laying



OBTAINING SMOOTH CONCRETE BASE FOR WOOD BLOCK PAVEMENT WITH SMALL ROLLER ON TEMPLATES.

blocks was the added cost entailed by reason of getting a smooth top concrete. There was no question as to its possible superiority to the mortar or sand cushion but how to do it was the question. We have had very little trouble from our method of using a sand cushion here in Minneapolis and we have laid over two million square yards since 1902. We are, however, beginning to have some trouble from some of our older pavements on account of the water getting in under the blocks and causing expansion. This difficulty can be attributed more to the method employed in cleaning, using squeegees and power flushing thereby keeping the pavement continuously wet and very wet most of the time. There have been many suggestions made at various times and places as to the best method to pursue and we started in to try out several methods.

Experimental Work

We began experimenting with templates made to the proper crown of the street, having iron stakes attached to hold them to the proper elevation. We used a screed drawn over the templates but on account of the larger aggregates it was

difficult to bring the concrete to the proper grade. We then used a large iron roller about 10 in. in diameter and 6 ft. in length having a long handle and drawn by hand across the screeded concrete. This worked fairly well but would leave marks in the concrete and we then used a belt to obliterate the marks but this was not entirely successful.

Use of Templates and Roller

We obtained the best results by the use of the templates and a small sized roller to smooth the top of the concrete as shown in the accompanying photograph.

The roller was made from a 3 in. wrought iron pipe 13 ft. long filled with sand to increase weight, the handles were fastened to a round block of hard wood about 6 ins. long which

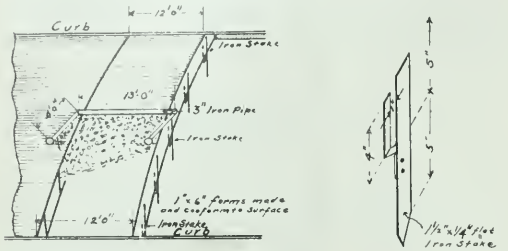


DIAGRAM SHOWING METHOD OF ROLLING CONCRETE BASE FOR WOOD BLOCK PAVEMENT, MINNEAPOLIS, MINN.

was driven into the ends of the pipe. The templates were made from 1x6 in. lumber, four pieces for each complete template, the upper edge being finished to the contour of the street, and requiring at least three templates for working continuously.

These templates were placed 12 ft. apart longitudinally of the street as that was about the limit of the amount of concrete that could be handled by a concrete mixer using a 20 ft. boom. These templates were held to the proper grade by iron stakes with brackets driven into the ground. These stakes were made from 1½x¼ in. flat iron in the form as shown in the drawing. There was also required a removable bridge from which the workman removed the templates from the finished section and from which he filled the space caused by such removal and finished the filled in material with an ordinary long handled float.

By the use of the above described equipment we could do the work almost as rapidly as ordinary concreting and the cost was only a little higher taking into consideration the fact that there was no sand or mortar cushion to be laid.

The Selection of the Value of the Factor "n" in Sewer Design

By Paul E. Green, Member American Soc. C. E., of Marr, Green & Co., Engineers, 17 N. La Salle St., Chicago.

Many articles have been published on the proper value to be assigned to the factor "n" in the Kutter formula, when designing sewers. Quite a few experiments have been described in which "n" has been determined by actual observation. From these discussions certain definite conclusions have been reached and in the case of vitrified tile pipe sewers, it is rather usual to recommend that "n"=.013 to .015. It is the purpose of this article to show that such a definite figure is not justifiable, and that rigidly to follow such a direction is liable to result in defective work.

Definite Value of "n" Not Justifiable

In the average system of sanitary sewers the 8 in. internal diameter pipe will normally compose from 80% to 90% of the total. This size of pipe is likely to be used on a line for several hundred, or in some cases, for two or three thousand feet. Not only is this true, but many lines of parallel sewers will be necessary, particularly if the town layout is on the usual grid-iron plan. The outlet or discharge point of these sewers will generally determine the grade of the main interceptor, which, of course, will be of larger size. Since the topography is rarely ideal, and since usually the main interceptor is the deepest and most expensive line to lay, and must be below the grade of its laterals, it follows that anything that determines the rate of slope of the laterals is a factor of great economic importance. Often some of the laterals, and at times, the trunk must "buck the grade."

Construction Conditions Determine Value of "n"

"N" is a factor of roughness of the wetted surface. For tile pipe it is determined by two things:

1st—The smoothness of the materials, and,

2nd—The care with which joints are made.

Of these, the second is the larger factor.

Probably the most complete summary of the value of "n" will be found in Vol. 1 of Metcalf & Eddy's work on American Sewerage Practice. In this work the authors recommend, "under reasonably good operating conditions" a value of "n"=.015 for vitrified pipe sewers. The writer agrees with them. "Under reasonably good operating conditions" n=.015 is nearly ideal, but the trouble is that the operating conditions do not determine the value of "n". It is largely determined by the construction conditions.

We will assume a minimum velocity of 2.5 ft. per second and an 8 in. pipe, then:

1. for "n"=.011, the slope in feet per thousand is 3.9
2. for "n"=.013, the slope in feet per thousand is 6.3
3. for "n"=.015, the slope in feet per thousand is 9.0

Relation Between Value of "n" and Depth of Sewer Cut

The difference between the first and third of these figures is over 5 ft. per thousand and means that an 8 in. vitrified pipe sewer will be 5 ft. deeper at the end of a 1,000 ft. run if laid on the third grade than on the first, and 19 ft. deeper at the end of 2,000 ft. The difference in value between the second and third "n" in 2,000 ft. means 5.4 ft. in depth of cut. It should be remembered that in deep sewers, we "pay through the nose" for each foot of additional depth, particularly in bad soil.

Flat Grades

It is well known that there is no difficulty in securing, by means of careful workmanship, a value of "n"=.011 in vitrified pipe sewers. Williams & Hazen in their Hydraulic Tables, page 52, use a value of "C"=110, giving a velocity of 2.5 ft. for 8 in. pipe with a slope of 4.39 ft. per 1,000, which corresponds to a value of less than .012. Chas. P. Chase, M. Am. Soc. of C. E., Consulting Engineer, informed the writer that over 20 years ago he designed and supervised the construction of a system of sewers for the City of Mendota, Illinois, in which his ruling grade for nearly the entire work on 8 in. sewers was 2.5 ft. per thousand. He examined this system a few years ago, and found the surfaces clean, no deposits, and no complaints of trouble. Messrs. Hill & Ferguson, Consulting Engineers, New York City, designed a system of sewers for the U. S. Housing Corporation's development at Paradise Creek, Va., during the summer of 1918, in which the grades were 2.5 ft. per 1,000 for 8 in. sewers.

Grade Reduction to Save Deep Cutting

The writer has done the same thing for the past ten years, and has had no trouble. Engineers of experience are continually doing it, and yet our technical literature almost universally recommends that "n" shall be not less than .013, and preferrably .015. The Engineering Staff of the U. S. Housing Corporation, of which the writer had the honor to be a member, in its instructions to its designing engineers, recommended "n"=.013, but when the designs came in after following these instructions and showed in many cases heavy cuts, we promptly reduced the grade in order to cheapen the cost and improve operation.

Conclusions

It would seem from the above, that engineers are preaching one thing, and practicing another. The average designer is frequently liable to be more conservative in his writings than in his work. But in view of the above, the writer is willing to go on record, as follows:

1st—That with good average workmanship tile pipe sewers may be safely assumed to develop an "n" not greater than .012.

2nd—That in any bad, wet soil, we are much more likely to get "n"=.011 at the bottom of a 10 ft. cut than we are "n"=.015 at the bottom of a 20 ft. cut. This is because of the much greater difficulty of getting good work in the second case than in the first.

3rd—That the saving attained because of less depth required will pay for the more careful workmanship required many times over.

4th—That few experienced engineers permit the value of "n" to bother them at critical times, but design and construct on a rational basis, which takes into consideration the character of the soil and the depth of the sewer.

The Brick Highways of Ashtabula County, Ohio

By Ray N. Case, County Engineer, Ashtabula County, Jefferson, Ohio

When I took charge of the highway department of Ashtabula County, in the fall of 1913, there were 40.4 miles of improved road out of a total of 1,256 miles of highway in the county, approximately 3 per cent being improved. Of this mileage 1.52 miles was of brick, 2.61 miles of one course concrete and 36.27 miles of tar and water bound macadam.

Few Roads Built Prior to 1913

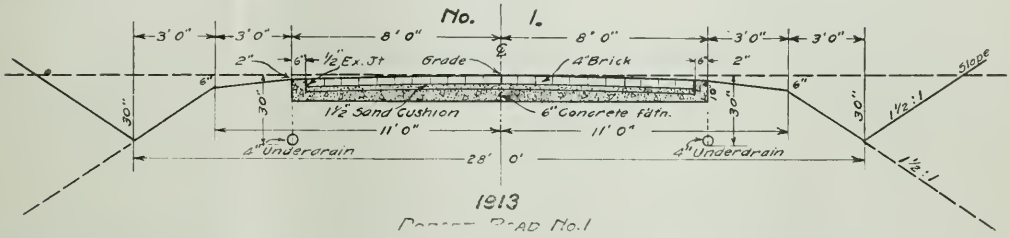
The brick road above mentioned was constructed in 1908 using a fire clay brick upon a natural sand base, with sand filler. This section of road is on the Main Market Road No. 1 of the State Highway System, and aside from settlements, due largely to seepage from street car track which traverses the entire length of the highway, the road is in very good condition at the present time.

main travelled roads of the county. It was their desire to follow largely the Inter-County Highway routes, but as Intercounty funds, or State co-operation, could not always be obtained, the greater number of our highways were constructed witthout state aid, and sometimes deviated from the Intercounty routes.

As the macadam roads previously constructed were narrow they rutted easily, so it was decided that if we were to construct a narrow road, it must be of such material as would withstand abrasion, and concentrated traffic and at the same time be economical in design and construction.

The Dorset Brick Road a Model

The first brick highway constructed under my charge was known as the Dorset Road. This highway is 3.25 miles in length, the brick wearing surface being 15 ft. in width, with two 6 in. curbs constructed integral with the base and flush with the brick surface. The base was a 1-3-6 mixture, using crushed furnace slag as the coarse aggregate. The thickness of the base was 4 ins. at the sides and 6 ins. in the center with a flat sub-base. (See Cross Section No. 1.) Before laying the brick a 1½ in. sand cushion was spread over the base and compacted by hand rolling. This highway was constructed upon a clay subsoil that was practically impassable to traffic during the spring and fall months. After four years of heavy traffic, very few defects have occurred. Some longitudinal cracks have developed, but to date no maintenance of the surface has been required. This road was the first of its kind in this section of the state, and is considered by many a model road in every particular.

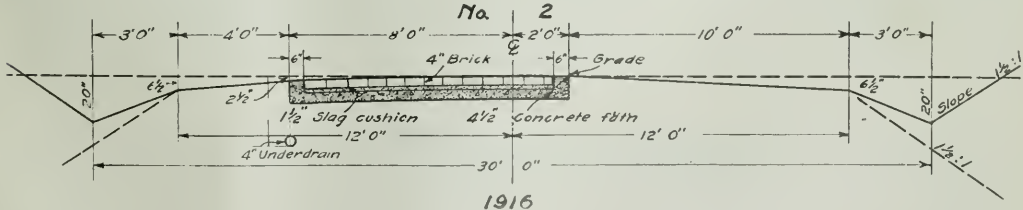


1913

PLAIN ROAD No. 1

The 10 Ft. Brick Road

In 1915, the first 10 ft. brick roads were constructed. In this year 25 miles were placed under contract. These roads were designed 10 ft. in width, 9 ft. of brick with flush curbs 6 ins. in width and upon a 4½ in. gravel concrete foundation, using 1½ in. sand cushionwith crown of ¼ in. to the foot. (See Cross Section No. 2.) This type of road constitutes our greatest mileage, and while some criticise the narrow road, it nevertheless is the highway for the rural districts.



1916

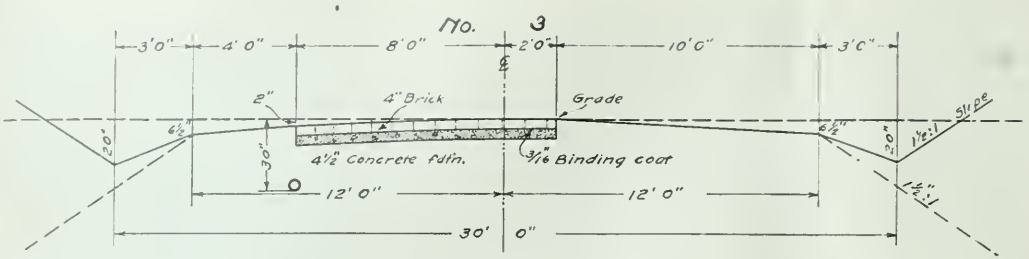
I.C.H. No. 151 JEFFERSON—ANDOVER ROAD SEC. "J"

The concrete roads were constructed 16 ft. in width, while the macadam roads were 9 and 16 ft. in width, the greatest mileage however being only 9 ft. in width,

County System of Highways

In the winter of 1913-14, a county system of highways was decided upon by the County Commissioners, covering the

The 10 ft. dirt side road gives the horse drawn traffic a desirable road in summer, and in winter, by reason of better drainage is made passable for any kind of travel. With the brick section placed at one side of the road, less maintenance of the shoulders is required than would be the case, were the improved section placed in the center of the travelled roadway.



1916

WAYNE ROAD No. 1

Narrow Pavement on One Side of Roadway

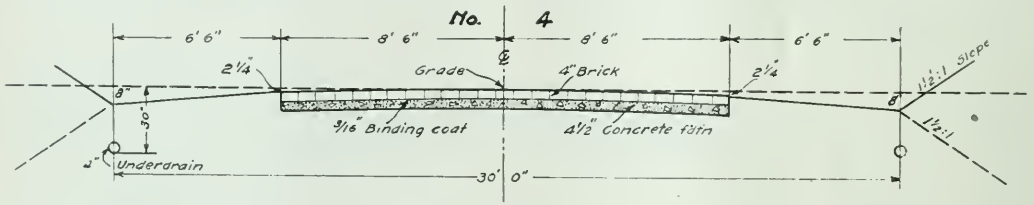
Ashtabula County is largely a dairying community and the ability to use the highway at all times of the year is a great help to the farmer. A 16 ft. highway on main roads where there is a heavy automobile traffic, would be more desirable, but in the outlying townships a narrow road, built on the right side of the road leading toward the towns or railway depots provides a fine highway at a much less cost than would be the case if wider roads were constructed.

Slag Bed Desirable to Give Stability

I believe that slag used as a cushion, or bed, is much more desirable than sand, for the slag as soon as compacted, was found to be a protection against settlement which occurs in pavements where sand is used as a cushion. It was from the use of slag as a cushion that the monolithic type of pavement we are now constructing, partly had its inception. Engineers, in the past, recommended the use of the sand cushion to give resiliency to the pavement. The use of the slag cushion destroys any resiliency that the sand had supplied; hence, that factor, or weakness, in the construction of a brick pavement was eliminated. Any tendency to give, or change in shape or form of a brick road results in failure, and the more rigid and unyielding we can construct a pavement the longer it will resist abrasion and impact.

Slag Bed Supercedes Sand

A very striking illustration came under my observation, relative to the use of slag as a cushion, or bed. On one road, construction was started late in the season of 1916 and while the concrete base was completed, we were unable to grout about 1,000 ft. of the brick pavement which had been laid and rolled upon the previously constructed slag cushion. Owing to the fact that traffic could not be detoured around this section, we permitted travel over the ungrouted portion of the road. The next spring we found the road showed very little settlement at any point. The loose brick were removed and the slag cushion was found to be practically united with the concrete base. As no settlements had occurred, the brick showed little evidence of wear, and after cleaning, were relaid and grouted without being rolled, which is required where sand is used for a cushion.

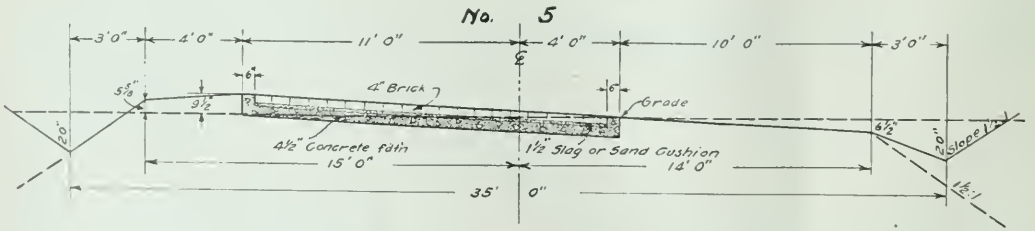


1916

MAIN MARKET No. 1 GENEVA WEST SECTION

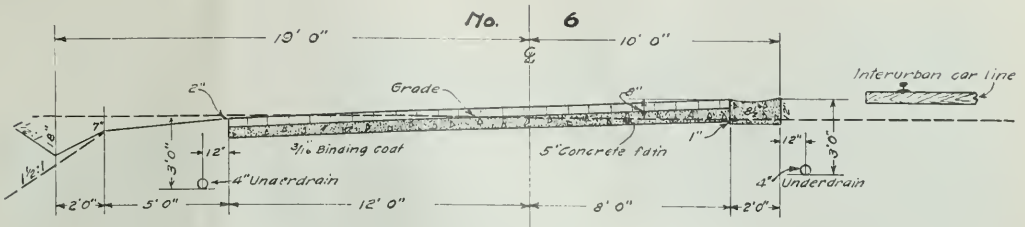
The Monolithic Type

When we found that the sand cushion was not absolutely necessary in the construction of a brick road, the monolithic type was decided upon, and in 1916, the first roads of this type were constructed. One road 2.95 miles in length and 10 ft. in width was constructed in Wayne Township (See Cross Section No. 3) and 2.05 miles, 17 ft. wide in Geneva Township. (See Cross Section No. 4.) The aggregate used was gravel con-



1916

SECTION SHOWING GENERAL METHOD USED IN SUPERELEVATING CURVES ON I.C.H. No. 151 JEFFERSON-ANDOVER ROAD SEC "J" CURVE WIDENED 5 FEET

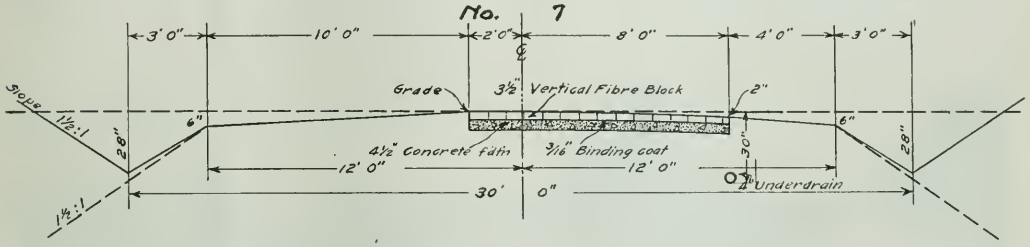


SECTION SHOWING SUPERELEVATED CURVE AT STA 620
MAIN MARKET No. 1. CLEVELAND-BUFFALO ROAD
CURVE WIDENED 4 FEET

glomerate graded in size from 1½ ins. down to sand with approximately 40 per cent passing through a ¼ in. opening or square mesh. Three hundred and fifty sq. yds. was the daily average, and as great care was taken a smooth road was the result.

A Parrish templet was used to cut the concrete base and a binder coat of 3-16 in. sand-cement of a ½ mixture was spread over the concrete base before the brick were laid. (I consider the ½ mixture of sand-cement rather strong, and on later roads have used a 1/3 and ¼ mixture with equally good results.) The brick were well inspected. This should be done as they are being placed upon the gravity conveyor, also after being laid in the sand-cement bed. The brick were rolled away. Very few longitudinal cracks have appeared, although transverse cracks have appeared at intervals of 30 to 35 ft.

About 3 sq. yds. of this pavement have been replaced. The failure occurred on the inside of a 3-degree curve. The brick appeared to crumble, indicating expansion at this point. In repairing the pavement, we removed the loose brick, roughened the base, applied neat cement, relaid and grouted the brick in the usual manner. No transverse or expansion joints are used in our pavements, as I do not believe in their use. A thin cross-joint might be advisable at the intersection of vertical curves, when the grades are heavy, or at points of tangency on curves. Super-elevation of curves is a distinct advantage in the construction of highways, the amount of ele-



1918
CHERRY VALLEY – DORSET ROAD

by hand with a cylindrical roller 24 ins. in diameter and 36 ins. long, filled with sand.

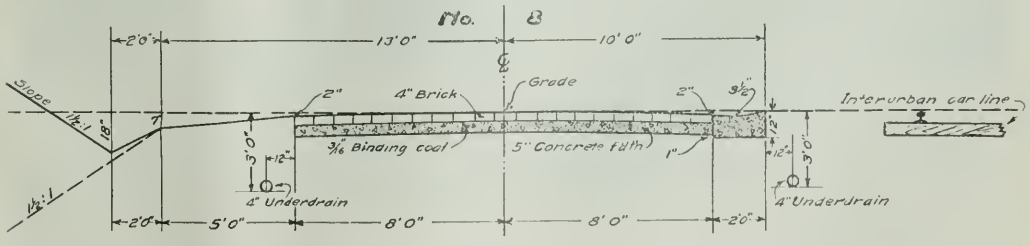
This road shows no transverse or longitudinal cracks, and only one settlement, due to a washout from under the entire slab, yet in this condition supported the heavy traffic for three months with a settlement of less than 1 in. in a span of 6 ft.

The 17-ft. road constructed the same year is wavy and rough, due largely to the fact that no templet was used in cutting the base. The templet provided for this work was not satisfactory, and the base was luted by hand. The road is now much smoother than when constructed, as too heavy a layer of grout was left on the surface, which has since worn

vation, in my judgment, being dependent upon the degree of horizontal curvature, with due allowanc for vertical curvature. We widen all curves over 3 degrees. This extra width varies from 3 to 10 ft. (See cross-sections Nos. 5 and 6.)

40 Miles of Brick Highway Constructed in County Since 1916.

Since 1916, we have constructed approximately 40 miles of brick highway. Of this total 15 miles have been of the monolithic type using a 4-in. wire-cut-lug brick upon a 4½-in. gravel concrete base, with 3/16 in. sand cement binder coat. One road 3.6 miles in length is constructed with vertical fiber brick 3½ ins. in thickness, with 3/16 in. sand cement binder



MAIN MARKET No. 1 CLEVELAND-BUFFALO ROAD

TABLE I—DATA ON BRICK ROADS IN ASHTABULA COUNTY, OHIO

Name of Road	Miles	Sq. Yds.	Feet Wide	Total Cost	Year Built	Contractor
Dorset Road	3.27	28,555	15	$56,272	1914	T. P. Fitzgerald
Morgan No. 4	3.36	17,795	10	44,925	1915	T. P. Fitzgerald.
Hampden-Andover	2.81	14,845	10	32,702	1915	T. P. Fitzgerald
Trumbull-Geneva	8.50	146,958	10-16	116,060	1915-16	B. F. Hewitt
M. M. No. 1 Geneva-Ashtabula	6.50	61,384	16	143,000	1916	Hart & Kemp
I. C. H. No. 2 Geneva-West	2.05	23,000	17-30	48,000	1916	T. P. Fitzgerald
Dorset-Denmark	.89	7,847	15	16,106	1916	T. P. Fitzgerald
Andover-North	2.05	10,775	10	23,474	1916	Linninger & Bennett
Andover-North Extension	.50	5,150	16-24	11,500	1916	Linninger & Bennett
Eagleville No. 2	.80	4,694	10	10,600	1916	T. P. Fitzgerald
Trumbull-Morgan	2.67	14,130	10	33,819	1916-17	Linninger & Bennett
Williamsfield Road	2.10	10,717	10	23,468	1916-17	B. F. Hewitt
Wayne Road	2.95	15,487	10	36,472	1917	Wade & Nims.
Morgan No. 4	.25	1,408	10	4,731	1917	C. W. Harrington & Son
I. C. H. 151 Jeff.-Andover	6.30	34,278	10	86,400	1916-17-18	Glenn Hadley
Cherry Valley-Dorset No. 1	3.63	23,500	10	63,890	1917-18	T. P. Fitzgerald
Kingsville-Sheffield	5.35	39,300	10-16	120,632	1917-18	T. P. Fitzgerald
Jefferson-Eagleville	3.46	23,258	10-16	66,257	1918	Hart & Kemp
Jefferson Village Extension	.60	5,209	10-16	12,000	1917	Glenn Hadley
Ashtabula-Plymouth	4.60	29,525	10-30	112,000	1918	T. P. Fitzgerald
Totals	62.64	411,815		$1,062,308		

coat. (See cross-section No. 7.) However, as this road has only been down a year, little can be said for or against it.

62 Miles Since 1913

Since 1913, we have constructed 62 miles of brick road in the county, 15 miles of which were of the monolithic type, previously described. Plans are prepared for 40 miles additional (all monolithic) which includes a 12-mile section of the main market route of the state. This highway (see cross-section No. 8) is designed 16 ft. in width, with a 4-in. wire-cut-lug brick upon a 5-in. gravel concrete base. A concrete gutter curb is placed along the street car side of this highway which provides 2 ft. additional width of pavement and at the same time provides better drainage to the highway. This highway is at the present time being advertised for 1919 construction.

Essentials in Design of Roads

In the design of a brick road, or in fact any other type of highway, at least three essentials must be kept in mind: First of all, proper drainage; without it, no pavement can last. Underdrainage is necessary, regardless of the kind of subsoil. Second, durability; build the best, as it is always cheapest in the end. Avoid heavy maintenance cost. Third, adaptability. A study of conditions should be made, traffic census

REPRESENTATIVE VIEWS ON THE BRICK HIGHWAYS OF ASHTABULA COUNTY, OHIO.

Top Row, Left to Right: Geneva Trumbull Road—Wayne Road—Geneva Trumbull Road. Bottom Row: Jefferson and Dorset Road —Andover No. 1 North Road—Geneva Road, West Section.

VIEWS ON BRICK HIGHWAYS OF ASHTABULA COUNTY, OHIO.
End Views on Geneva-Ashtabula Road—Center View on Wayne Road.

taken, and the type of highway selected that will best care for the most severe use. No matter how unimportant a road may be before it is improved, it at once becomes a main highway when improved.

Features of Present-Day Water Purification Practice

A Non-Technical Review Written for Municipal Officials.

By Milton F. Stein, Civil Engineer, Chicago, Ill.

Although the purification of water for public supply has been on a well-established basis for several decades and of late years purification plants have been built in ever increasing numbers, the writer not infrequently meets municipal officials, health officers and others interested in the public well-being, who are not familiar with the basic principles underlying this art, its scope and limitations, and its relative position in the civic organism.

This is not so surprising as may at first appear, for while the periodical literature relating to the subject is voluminous most of the papers published have been of a technical nature, or else descriptions of specific purification plants, in which special design features and details have been emphasized, rather than the fundamentals of the process and the functions of the various appliances essential thereto. Furthermore, during the development of this art, and of other phases of sanitary engineering, and the acquisition of a better knowledge of the interrelation existing between these phases and of the significance of the various factors involved, there has been not only an improvement of the methods and devices used, but also a readjustment, from time to time, of viewpoint as to the purpose and accomplishments of water purification. For these reasons, and because the revival of activities in municipal construction during the coming year should add interest to this subject, it would seem permissible and perhaps not unprofitable to discuss its present status, and to touch upon certain closely allied questions.

What is Meant by "Water Purification"

There is often confusion of mind among those not well versed in the matter regarding what "impurities" in the water it is desirable to remove, which is probably engendered by the promiscuous reading of literature on the treatment of industrial and boiler waters as well as of municipal supplies. The impurities in drinking water in order of their importance are:

1. Bacteria and other forms of microscopic plant and animal life which may cause disease or by their presence enhance the possibilities of disease.

2. Sewage pollution, which with the dual use of our water courses for both drainage and water supply, is almost inevitably present, although usually in great dilution, and the removal of which is desirable for aesthetic reasons.

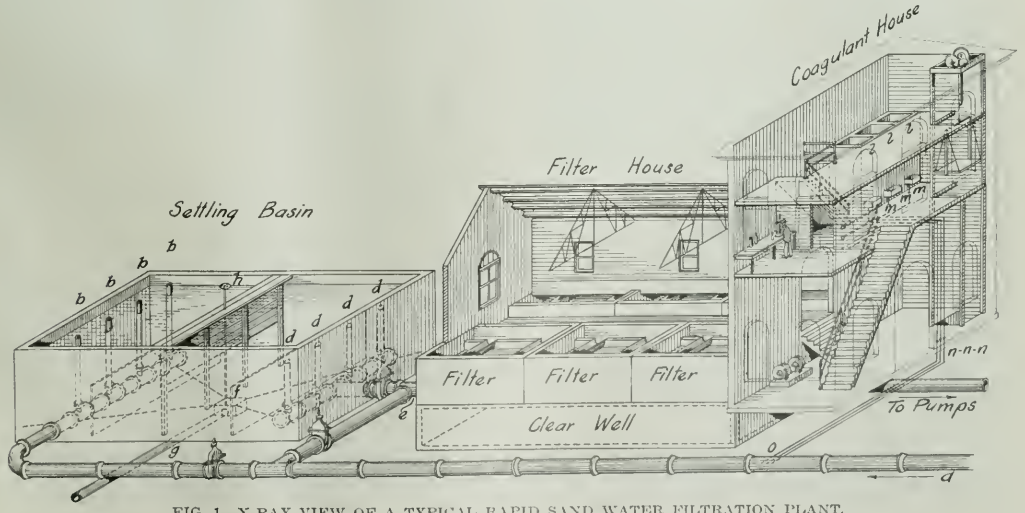


FIG. 1—X-RAY VIEW OF A TYPICAL RAPID SAND WATER FILTRATION PLANT.

3. Turbidity, caused by soil-wash, clay or silt, not necessarily harmful, but unpleasantly suggestive.

4. In specific cases, where waters contain large quantities of salts of calcium and magnesium, or carbonic acid, causing the combination of objectionable qualities called "hardness," or where iron or manganese are present, these may be termed impurities. With these exceptions the mineral salts naturally present are desirable, and the experienced water expert does not attempt to improve on nature's handiwork by their elimination.

Methods of Water Purification

The confusion of mind mentioned previously extends also to the methods of purification, partly because of the use of several designations for the same method, and partly because of the obsolete processes described in the older literature and a few of which are artificially sustained at the present time, although far past their natural span of life. The two processes of most importance in the development of water purification were, "natural," "slow sand" or the "English" system of filtration, and the "mechanical," "American," or "rapid sand" system, both making use of filtration through beds of sand.* The slow sand system was used in quite a number of the older and larger plants in this country, and enjoyed an even greater vogue in Europe. The rapid sand system, while a later development, has so far outstripped its rival that it may be said, without fear of contradiction, that for municipal supplies this is the only process, with slight modifications to meet special conditions, which need be considered. Plain sedimentation, coagulation and settling, and other methods have had their advocates in the past, but thorough trial has found them wanting, and they have been largely replaced or supplemented by the rapid sand filter.

Rapid Sand Filtration

Figure 1 shows a typical rapid sand filtration plant. The raw water is pumped from the river to the settling basin thru the main *a*. As it passes the point o, en route, a coagulant solution is added. This is generally a solution of aluminum sulphate, although sometimes iron sulphate is used. This coagulant, combining with the natural salts in the water, forms a flocculent precipitate, which greatly assists in the settling out of silt and suspended impurities, and also forms a jelly-like film over the surface of the filter sand, which is of a very fine, porous, sponge-like structure, allowing water to pass through readily, but retaining even the most minute solid matter, such as bacteria, etc. The use of a coagulant is of fundamental importance, as without it very little of the fine suspended matter and bacteria would be removed in the settling basin and the filters would act merely as coarse strainers, rendering the whole process very inefficient. While the theory of coagulation seems very simple, it is profoundly affected by the condition of the raw water, temperature, reaction period, so that it really is a very interesting example of colloidal chemistry.† Before designing any plant, a thorough examination of the coagulating qualities of the water should be made, so that the parts of the plant affected thereby may be properly proportioned, as this has much to do with the success of the plant. The use of a coagulant is harmless, as it all enters into the flocculent precipitate, which is insoluble, and either settles out in the basin or is retained upon the filters.

The water enters the settling basin through the risers *b-b-b-b*. In the settling basin the chemical reaction between the coagulant solution and the alkaline salts in the water is carried to completion, and the resulting precipitate settles out, carrying with it a large proportion of the bacteria and silt originally present in the water. Periodically the accumulated precipitate is flushed out through the valve *f* operated by the hand wheel *h*. The settled water enters the pipes *d-d-d-d*, and flows to the filters.

Referring now to Figure 2, which shows a cross-section of the same filter plant, the settled water enters thru the conduit *e*, from which there are branches *p-p* to each filter unit. Entering the filter, the water passes downward through a layer of sand, usually 30 to 36 ins. deep, on the surface of which, and forming the true filtering medium, is the mat of coagulum already mentioned. Then flowing through a substratum of gravel it enters a manifold of perforated collector pipes, which carry it to a common header leading to the filtered water basin, from whence it is pumped to the consumer.

Each filter is equipped with a rate controller, which automatically maintains a constant rate of filtration, a very essential element in the success of the process.

Naturally there is an increasing accumulation of impuri-

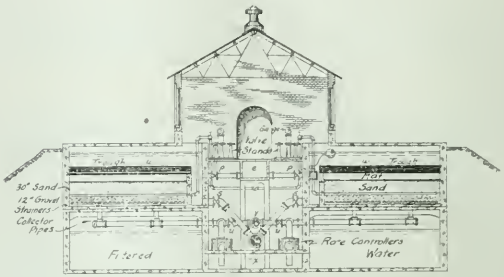


FIG. 2—CROSS SECTION OF A RAPID SAND WATER FILTER PLANT.

ties on and in the filter, which must be removed periodically, as a rule daily. This is accomplished by washing the filter. To do this, the inlet and outlet valves are first closed; then the sewer valves *s-s* are opened, and lastly the wash water valves *u-u*. This admits filtered water from the pipe *r*, which may be connected either to the city mains or preferably to a special elevated tank, to enter the collecting manifold and stream upward through the sand, raising this bodily and thoroughly washing it. The wash water and contained impurities escapes into troughs *w-w*, which carry it into the sewer *x*. After about five minutes washing the sand will be perfectly clean, and the filter is again put into commission.

Attention may be called to the coagulant house in Figure 1. Here are shown the solution tanks *l-l-l*, the orifice boxes, *m-m-m*, which measure out the solutions at a uniform rate, the coagulant pipes *n-n-n*, the elevator for handling chemicals, and the laboratory.

These are the essential features of a rapid sand filter plant. In large plants, there are necessarily many additional devices and complications.

What Filtration Will Accomplish

If this article were written only for those fairly familiar with filtration this section could be omitted, but for the benefit of the uninitiated, it seems well to discuss briefly the results which are obtained by filtration. In the first place, the process above described will remove all suspended matter from a water, even the most minute. It will even go somewhat further, in that it will remove at least part of substances in a condition of false or colloidal solution, such as the coloring matter which gives to some waters a yellow or brownish tinge. Of the suspended matter thus removed, the bacteria present in the water form a part, which while often only small in comparison to the whole, is yet the most important, since the removal of the bacteria renders the water

*For descriptions of the various processes and the theory of filtration, see the author's book, "Water Purification Plants and Their Operation," John Wiley & Sons, N. Y., Publishers.

†"Colloids in Water and Sewage Purification," by M. F. Stein, Engineering Record, June 24, 1914.

perfectly safe and free from all possibility of causing disease.

Of the bacteria found in water many varieties are harmless, but there are a few which if ingested with food or drink, will cause grave diseases. One of the most formidable of these is typhoid fever, which is in part a water-borne disease. In recent years much preventive work as regards typhoid fever has been done, such as the elimination and screening out of flies, the cleaning up of contaminating material, the disinfection of patients' stools, the introduction of quarantine, etc. However, these measures do not guard against the infection of water supplies by typhoid carriers—those apparently healthy persons in whose intestines millions of typhoid bacteria are continually breeding and being constantly eliminated with the discharges of the bowels and the urine. The author has proved to his own satisfaction that typhoid carriers alone can easily cause all the typhoid fever usually found in communities using unfiltered water.

Typhoid fever statistics taken for a considerable period before, and after the use of filtered water, and previous to the introduction of the additional preventive measures above

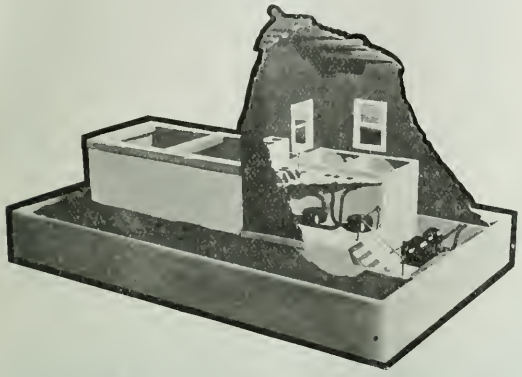


FIG. 3—SIMPLIFIED TYPE OF FILTRATION PLANT SUITABLE FOR TOWNS OF 5,000 AND LESS.

mentioned have as a rule shown such a marked reduction after filtration that there can be no doubt that this measure has by far the greatest weight in combating this disease, although by supplementary means the so-called residual typhoid can be largely eliminated.

Other intestinal disturbances, particularly those affecting children are largely done away with.

Like all works of mankind, filtration is not quite perfect. Occasionally a microbe or other bit of solid matter gets by. This is partly inherent to the process, and partly due to faults in operation. This has led to special studies of the process as a whole, in two directions; one to answer the question of how contaminated a water may be and still be capable of purification by filtration; the other of how to devise a finishing process which would put a quietus on any germ that might find its way through the filter. The answer to the first question is that there undoubtedly is a degree of contamination at which filtration becomes ineffective, but this is far beyond that point of pollution of a water supply where it ceases to be conceivable for human use. The second question has been answered of recent years by the installation of a chlorination apparatus in most filtration plants, by means of which a minute amount of chlorine gas is fed into the filtered water, which small as it is, is still capable, in the absence of other polluting matter to absorb it, of destroying the possible recalcitrant germ previously mentioned.

So that it may be safely said that filtration is capable of producing a perfectly clear and harmless drinking water under all conditions.

Water Softening and Iron Removal

By suitable modifications the rapid sand filter plant can be adapted for softening a hard water or removing iron from well supplies in addition to performing its usual functions. It is necessary to insert a note of warning here, however. Every such case must be carefully studied in conjunction with suitable experiments and the design should be entrusted only to an engineer with special experience in this phase of the work. Furthermore it must be remembered that the additional complications involved add considerably to the first cost as well as to the cost and difficulties of operation.

Water Sterilization

With the introduction of liquid chlorine as a sterilizing agent for water, sterilization has become very popular and has even been championed as a substitute for filtration. Certainly the compact and very practically designed apparatus now on the market, together with the fact that its first cost is almost negligible as compared to that of a filtration plant, must incline anyone in search of a water purification process toward it. However, it does not actually purify the water, but simply kills the bacteria. Moreover, other suspended matter absorbs chlorine as well as do the bacteria and in proportion to the amount present, so that with any appreciable turbidity, more chlorine must be added in order to be effective, which causes objectionable tastes. This limits the application of this process as a sole means of purification to comparatively clear waters. There is still another aspect to the question. If a community has once become accustomed to the use of bacteria-free water, a temporary return to the impure water to which it was formerly accustomed will cause a very extensive outbreak of intestinal trouble. So that if through carelessness, the continuous introduction of chlorine ceases or is not properly administered such an outbreak is very likely to occur. With a filtration plant, the several steps in the process and the necessity for frequent attention make a complete breakdown almost impossible, so that this danger is non-existent, while with liquid chlorine a cessation of treatment may occur thru the inadvertent turning of a valve, or failure to replace an empty tank. We must concede, however, that liquid chlorine is indispensable for emergency supplies or for use until a filtration plant can be built, and is very desirable as a finishing process even with filtration.

Design and Engineering Important

The large number of descriptions of filtration plants now extant have made it very easy for inexperienced engineers to enter this field and "design" plants, which are in fact nothing more than replicas of the ones described in engineering journals. Now, although the process of filtration seems quite simple, the details of the various steps are really quite intricate and subtle, and can be mastered only by extensive experience coupled with keen observation. In this respect the art of filtration somewhat resembles the late-lamented art of brewing, where an intimate knowledge of detail, based on long experience and on tradition handed down from master-brewer to apprentice, was a prerequisite to success. These replicas, while outwardly presenting a satisfactory appearance, are usually defective in the many small details which go to make a successful plant, and are a continual aggravation to the operator. Some interesting tales might be told of the same gross defect in design, found successively in a number of plants (and corrected at a cost of thousands of dollars in each case) which was ultimately traced to a draftsman's error in the plans of a plant much heralded in the engineering journals. There are also many plants of smaller size which, to the practiced eye, are obviously simply scaled down from some plant of larger size, and in which the elaborations of construction and complications of apparatus of the large plant have been needlessly retained, with a resultant higher first cost and an entirely unnecessary burden on the operation.

In every filtration project the conditions should be carefully studied with a scrutiny which will overlook no small but important detail, yet at the same time with a broadness of vision which can properly gage future requirements and apply to them the results of past experience. In the design many details can be incorporated which will make the finished plant better, or render the construction simpler for the contractor, or improve the operation. By proper supervision of construction, the leaky tanks, crumbling concrete and decrepit apparatus not at all uncommon in filtration plants of a few years' standing can be avoided. Certainly, in view of the long and continuous service expected of a filtration plant it is poor economy indeed to skimp on the engineering or to entrust it to incompetent engineers.

Operating Conditions and Their Control

With anything like proper care, the filtration plant is well safeguarded against a complete failure of the purification process. The arrangement in successive steps aids in this, since a falling off in the efficiency of one part of the process merely throws an additional burden on the other parts. Then again, the improvements accomplished at each step can be easily noted, the sufficiency of coagulation is determined by observation, or by simple chemical tests, and the condition of the end product is apparent to the eye, which can detect a very slight turbidity. This does not mean that the quality of the effluent can be judged by the absence of turbidity, but where the raw water is fairly turbid there is a correlation between clarity of effluent and removal of bacteria which to a large extent served to establish confidence in the process prior to the general introduction of bacteriological tests, and which if the truth be told, is still largely relied upon in many of the smaller plants. The author's experience with bacteriological tests in the hands of the small plant operator has not been encouraging. It is not to be expected that a non-technical man, who, likely as not, was pumping station engineer before the filtration plant was built, should appreciate the niceties of bacteriological technique necessary to secure reliable results. He will follow instructions, but it is doubtful whether the "b. coli" reported in the results should be ascribed to the water or the operator's fingers. There is no question but that filter results should be controlled by bacteriological tests, and to be of any great value such tests should be made daily. It is equally unquestionable that many of the smaller plants cannot afford a trained bacteriologist, nor can the state health department make the required tests, because of the burden of work that would result and the remoteness of location. Under these conditions recourse should be had to the independently practicing water chemist and bacteriologist, who can look after the tests for a number of plants.

Another feature of operation in which improvement can be effected is in the application of coagulant. Usually, in order to be sure of a "floc" too much coagulant is used. The laws of coagulation are sufficiently well known so that by a study of conditions and the analyses of the water, it is possible to prepare diagrams showing the amounts of coagulant to use for various conditions of the raw water, thus effecting a considerable saving.

In the smaller plants, as a rule, operating conditions are not all that could be desired, and there is very likely to be a gradual deterioration of plant equipment. For this reason there should be a periodic inspection by an expert, followed by such overhauling as he may recommend. This will prevent the deterioration reaching the point where permanent damage results, or becoming detrimental to the quality of the effluent.

Improvements in Present Design Practice.

In discussing future improvements it is convenient to divide filtration plants into two groups, those filtering over ten million gallons of water per day, and those of smaller capacity. Improvement can be effected in the coagulating and settling process in plants of all sizes, in respect to the point and manner of introducing the coagulant, in the method and degree of mixing the coagulant with the water, and in the design of the settling basins, to secure, as far as possible, a uniform flow. But there are limits to these improvements, as these processes are very much subject to the vagaries of wind, weather and temperature, so that a certain amount of inefficiency in them is unsurmountable under practical conditions.

In very large plants, especially where the water is softened, the difficulties of handling the enormous amounts of chemical are considerable, and much improvement can undoubtedly be made. This improvement can only be based upon actual experience, since so far only four of these monster plants have been built.

FIG. 4—PANORAMIC VIEW OF THE WEST SIDE MECHANICAL WATER FILTER PLANT AT CLEVELAND, OHIO.

As regards small plants, and particularly those serving populations of 10,000 or less, the tendency to copy from larger plants has already been remarked. Here a considerable simplification should be made over present designs, which should reduce the first cost. There should be greater ruggedness, both of the structures and of the apparatus. The temptation to introduce automatic devices of delicate construction into filtration plants seems to be irresistible to many engineers. The operator of the small plant is not a watch-maker or a safe expert, and has neither the time nor the inclination to fuss with delicate mechanism or to study out a complicated system of levers and gears. There is no function in water purification where mechanism is required for which a simple apparatus will not suffice. Such apparatus should be of simple and durable construction, and should operate on principles which can be understood by the type of men who will have charge of it.

Sewage Disposal Works in Reconstruction Period

By Harrison P. Eddy, of Metcalf & Eddy, Consulting Engineers, 14 Beacon St., Boston, Mass.

The general postponement of municipal construction of all kinds during the last two years has led to a large accumula-

tion of such work for which there is now more or less urgent demand. Naturally, consideration is being given to the order of precedence of work to be undertaken, and it is not always easy to decide which of several municipal improvements is most urgently needed, and what expenditures are justified. It may, therefore, be of interest at this time, to give consideration to data relating to the cost of some sewage disposal projects built under ante-war conditions and to the proportion of the budget likely to be required to meet annual charges. Some of the figures given were used by the writer in an address before the Dayton Engineers Club in 1916, and were published in Volume III of its Procedures.

TABLE I—CONSTRUCTION COSTS OF SEWAGE DISPOSAL WORKS

Project.	Cost to Dec. 31, 1915.	Population for which works were designed.	Cost per capita for population for which works were designed.	Cost per capita for population at time project was authorized.
North Metropolitan System—Boston Dilution in Harbor	$7,126,000	571,000	$12.48	$23.00
South Metropolitan System—Boston Dilution in Harbor	8,944,000	986,000	9.06	35.65
Worcester, Mass.—		*267,000		
Chemical precipitation and sand filtration	1,966,000	**163,000	9.31	25.60
Fitchburg, Mass.—Imhoff Tanks and Trickling		†87,000		
Filters	815,000	‡47,000	12.88	21.55
Gloversville, N. Y.—				
Sedimentation Tanks		‖30,000		
Trickling Filters		¶7,500		
Post-Filter Settling Tanks and Sand Filters	378,000	§20,000	15.26	20.20
Clinton, Mass.—Intermittent Sand Filters, Outfall Sewer and Pumping Sta.	149,000	x18,750	7.96	12.33
Average of per capita costs			11.16	23.05

* Applies to intercepters, separating system and new outfall sewer.
** Applies to sewage treatment plant and old outfall sewer.
† Applies to intercepter.
‡ Applies to treatment plant—part for 55,000—part for 40,000.
‖ Applies to intercepter and treatment plant, excepting sand filters and sludge beds.
¶ Applies to sand filters.
§ Applies to sludge beds.
x Assuming 750 persons per acre.

Total and Per Capita Costs of Sewage Disposal Works

Data are given in Table I, showing the total and per capita costs of sewage disposal works for two large Metropolitan Districts at Boston, for the City of Worcester, a middle size industrial centre, and for Fitchburg, Gloversville and Clinton, three relatively small industrial communities.

Description of Works

The Metropolitan systems serve very large populations and comprise intercepting sewers, pumping stations and harbor outfalls, as the sewage is disposed of by dilution in Boston Harbor. This method is frequently assumed to be particularly simple and relatively inexpensive, yet it will be seen from the figures given that the per capita costs are very similar to those of the smaller cities, where sewage treatment has been provided.

At Worcester, the cost given includes the intercepting sewers, the sewage treatment plant and sewers and drains required for providing separate systems of drains and sewers in certain large districts previously served by combined sewers. The sewage treatment plant comprises a chemical precipitation plant, including sludge presses, capable of treating all of the sewage of the city, and over 70 acres of intermittent sand filters capable of treating about 25 % of the city's sewage.

At Gloversville unusually elaborate treatment works were provided because the sewage mingled with large quantities of industrial wastes, is discharged into a very small creek, the condition of which had been the subject of litigation for many years prior to the completion of the sewage treatment plant. These works comprise an intercepting sewer, vertical flow sedimentation tanks, trickling filters, humus sedimentation tanks, intermittent sand filters and sludge drying beds.

The City of Fitchburg is provided, for the most part with combined sewers. The works provided for the solution of the problem of disposal, comprise an intercepting sewer, an outfall sewer consisting of a long cast iron inverted siphon, Imhoff sedimentation tanks, trickling filters, humus sedimentation tanks and sludge drying beds. While it is essentially a manufacturing city, a very small quantity of industrial wastes is discharged into the sewer system.

It will be seen that the per capita cost of the several disposal works included in Table I, varied from $7.96 to $15.26,

TABLE II—INTEREST, MAINTENANCE AND OPERATION COSTS OF SEWAGE DISPOSAL WORKS, 1915

Project.	Interest on Investment at 3½% per capita.	Maintenance and Operation Cap.	Total per capita.	Est. total population of district 1915.
No. Metrop. System, Boston—Dilution in Harbor	$0.41	$0.29	$0.70	601,810
So. Metrop. System, Boston—Dilution in Harbor	0.71	0.25	0.96	438,580
Worcester, Mass.—Chemical Precipitation and Sand Filtration	0.43	0.37	0.80	162,697
Fitchburg, Mass.—Imhoff Tanks and Trickling Filters	0.72	0.26	0.98	39,656
Gloversville, N. Y.—Sedimentation, Trickling Filters, Post-Filter Sedimentation and Final Filtration through Sand	0.63	0.27	0.90	21,178
Clinton, Mass.—Intermittent Sand Fil., including Pumping	0.39	0.57	0.96	13,192
Average	0.55	0.33	0.88	.....

TABLE III—NET CITY EXPENDITURES PER CAPITA, 1915.
(Data from U. S. Census Financial Statistics of Cities)

Item.	Worcester, Mass. Est. Pop. 157,499		Dayton, O. Est. Pop. 123,794		Ave. of 44 Cities Pop 100,000 to 300,000 in 1915	
	Expenditure.	Proportion.	Expenditure.	Proportion.	Expenditure	Proportion.
Gen. government	$0.97	4.1	$1.18	7.1	$1.17	6.1
Police	1.78	7.6	1.32	7.9	1.60	8.3
Fire	1.77	7.6	1.44	8.7	1.73	9.0
Other protection	0.11	.5	0.09	.5	0.18	.9
Health & sanitation	1.77	7.6	1.14	6.9	1.53	8.0
Highways	3.14	13.4	1.73	10.4	1.98	10.3
Charities, Hosp. & Corr.	1.74	1.4	0.65	3.9	0.68	3.5
Schools & Education	6.77	28.9	4.49	27.0	5.08	26.5
Libraries	0.50	2.1	0.37	2.2	0.22	1.2
Recreation park and playground	0.63	2.7	0.28	1.7	0.60	3.1
Miscellaneous	0.43	1.8	0.39	2.3	0.34	1.8
Water supply	0.57	2.4	0.97	5.8	1.10	5.7
Interest	3.25	13.9	2.60	15.6	3.00	15.6
Total of items shown	23.43	100.0	16.65	100.0	19.21	100.0

based upon the populations for which the works were designed to relieve. It is customary, however, in building such works, to make liberal allowance for the growth of the communities in the future, provision frequently being made for populations estimated to be tributary to the works in from 20 to 40 years after the date of their design. The effect of this allowance is shown by the difference in cost per capita of population for which the works were designed, and that obtaining at the time they were authorized.

Interest, Maintenance and Operation Charges

The interest, maintenance and operation charges for these works are given in Table II.

It is rather surprising to find that the cost of disposal by dilution in Boston Harbor, where operation costs consist chiefly of pumping the sewage, is practically the same as that in the smaller communities, where sewage is treated by artificial processes.

It is not easy to decide in all cases what proportion of its annual income a community is justified in expending for the treatment of its sewage, and the payment of annual charges upon its disposal works. In this connection it is interesting to note the proportion of annual income devoted to each of the principal municipal activities. Such a sub-division of expenditures is given in Table III, for Worcester, Mass., Dayton, Ohio and 44 cities in this country having a population of from 100,000 to 300,000. These figures are taken from the 1915 U. S. Census, Financial Statistics of Cities.

The figures in Table III are not given with the idea that they can be applied directly to any community, but rather to give those interested the opportunity to make such comparisons in specific cases as may appear to be justified.

In considering the cost of maintenance and operation of sewage disposal works, Table II, it should be noted that in the six cases cited, the disposal works whether they comprise pumping stations or sewage treatment plants, are faithfully operated under skilled supervision. In this respect they differ from many more or less similar works which after completion are practically abandoned and perform only a limited part of the service for which they were designed and which they are capable of rendering under proper operation and maintenance.

Proper Operation and Maintenance

This failure properly to operate sewage disposal works is a matter of serious importance to the public. The need of accomplishing a specific result at the minimum cost, has led to the highly technical bacterial methods of disposal, which require skilled supervision to ensure their good operation. Lack of such supervision leads in many cases to failure, which is not the result of faulty design, but of operation, and indicates that a campaign of education is necessary to bring home to the public the necessity of appropriating adequate funds for proper operation and maintenance of their sewerage works.

A New Line of Steam Shovels

Because the sentiment of the country is strongly for the rapid completion of a universal system of dependable highways, and realizing that road-building machinery of the future must have a wide range of usefulness, a complete new line, the Type OO Series, has been added to the line of earth moving and handling equipment produced by the Thew Automatic Shovel Co., Lorain, Ohio. This machine is equipped either as a full-circle swing shovel or crane, and is provided with either steam, gasoline or electric power. For regular shovel work, it carries a ½-yard dipper. Double-drum mechanism may be furnished for clam-shell or crane operation. It weighs only 14 tons.

City Pavements for State Highways in Connecticut

By Charles J. Bennett, Mem. Am. Soc. C. E., State Highway Commissioner, Hartford, Conn.

The State Highway Department of Connecticut has committed itself within the past six years to the policy of constructing hard surfaced pavements on heavily travelled state highways.

Inter-City Hard Surfaced Roads

Many of the highways through the thickly-settled sections of the state are subjected to a traffic equal in weight, if not in amount, to that on the main streets of a large city. The centers of population are manufacturing towns, and the traffic between towns demands service for the entire year. With the ordinary type of highway, such as gravel or macadam, this is not practical, or, if practical, causes such a large expenditure for maintenance as to make it unwise to construct this cheaper type of pavement. On that account, many miles of hard surfaced pavement, either of concrete or improved pavement with a concrete base, have been constructed with the result that motor vehicles are operating for the entire year over these sections with comfort and very little inconvenience.

The Burnside Avenue Pavement in East Hartford

As an illustration of the above practice, during the season of 1918, the Department constructed approximately 20 miles of this type of pavement under the extremely adverse conditions of the labor and material market, and at a cost which, in ordinary times, would have been considered excessive. Nevertheless, the result of the improvement seems to indicate that the expenditure was justified. A particular instance which can be used as an example is the improvement of what is known as Burnside Avenue in the Towns of East Hartford and Manchester, lying between the City of Hartford and the Town of Manchester, Conn. and on the main route from Hartford to the easterly portion of the State.

Practically all of the road from Hartford to Manchester had been improved by the State, but on one particular section approximately two miles in length, the pavement was old and worn thin. A macadam road had been constructed and was giving considerable trouble at certain seasons in the year on account of breaking through, and was rough and full of cup holes practically all of the time. The cost of maintenance had increased to practically $1,000 a mile, and it was considered advisable to construct a new pavement during the season of 1918.

Sheet Asphalt on a Concrete Base

The type of road selected was sheet asphalt pavement on a concrete base. The work was of such a character that it was possible to figure the excavation per square yard very easily, as it was practically of a standard depth for the entire length of the highway to be constructed. Consequently, the price bid was on the basis of a square yard, and the entire cost of pavement, including excavation, 6 ins. of concrete base and 3 ins. of sheet asphalt top, was awarded for $2.50 per square yard. The concrete base was laid in the proportion of 1 part of cement, 3 parts of sand and 6 parts of crushed stone. The sheet asphalt was of standard type, consisting of 1½ ins. of binder and 1½ ins. of top laid under the standard specifications for sheet asphalt pavements.

Many Mechanical Devices Employed

On account of the extremely bad labor conditions, it was necessary to employ as many mechanical devices as was possible. Inasmuch as there was a trolley line located alongside, or in the highway, for the entire distance, the crushed stone for the concrete base was delivered by trolley cars and dumped directly in place on the sub-grade, so that it could be handled directly into the mixture. Sand was delivered in the same manner.

The sub-grade excavation was done by employing a steam shovel of the ordinary highway type which broke up the

old macadam road and loaded it into carts for delivery on side roads which were hardened by the use of the old stone. Sufficient excavated material was left to construct the shoulders against the new asphalt pavement.

On acount of the possibility of greater speed in delivery, the hot mixture for the asphalt surfacing was delivered by motor truck from a permanent plant located in the City of Hartford, with an approximate haul of six miles. There was no difficulty experienced in delivering the mixture, but on the whole, this method of delivery was satisfactory.

The pavement mixture was sampled by chemists at the plant in Hartford, and careful records kept of the mixture.

The work was done, under the supervision of the State Highway Department of the State of Connecticut, by the Edward Balf Company, general contractors of Hartford, Conn.

Some Design and Constructional Features of the Rideau River Intercepting Sewer, Ottawa, Canada

By L. McLaren Hunter, of City Engineering Department, Ottawa, Ontario, Canada

The Rideau River Intercepting Sewer is located in the southern district of Ottawa, Ontario, and is 17,900 ft. long. It was constructed to drain a portion of Ottawa South, and to give a greater depth for house drainage in other portions of the same district. It will also drain a part of Ottawa East.

The city engaged the firm of consulting engineers, R. S. & W. S. Lea, of Montreal, to make a report on the necessity for and the design of the interceptor.

In designing the interceptor it was important to adopt such a route and grade as would permit of its convenient incorporation in the main drainage scheme which must be provided eventually for the whole city of Ottawa and suburbs.

The area of the section drained is 1,060 acres, 36 per cent. of which (380 acres in the Ottawa South and Ottawa East districts) is already sewered on the combined system.

The present main sewer has its outlet in the Ottawa River at Edwards Mill, at the foot of John Street, and crosses the canal at Somerset Street, where the Rideau River Interceptor commences. Some of the features of the Rideau Interceptor are here described as reported by Mr. Hunter to The Canadian Engineer.

Sections

The first section was constructed of segment tile 60 ins. in diameter, running from Somerset street to the Gas Company's property. The next section, of 54-in. pipe (part segment and part concrete pipe) runs from the Gas Company to Clegg street. The section from Clegg to Windsor was constructed of 48-in. concrete pipe—(this is being continued along Windsor to Bank and Grove street and is called the Ottawa South sewer extension, although really an extension to the Rideau interceptor). A 30-in. concrete pipe is carried along Cameron to Leonard. This extension is 4,000 ft. in length.

Work was commenced in December, 1915, by day labor, under Foreman J. J. Sullivan, a concrete bellmouth being built, 60 in. off 84 in. at 40 ft. radius to connect with the main drain. A gang of 72 men were employed during the winter of 1916-17 and rapid progress was made.

The gradient for the whole length of the interceptor was 1 in 1,000, three crossheads being used every 100 ft. for sighting purposes.

Tunnel Section

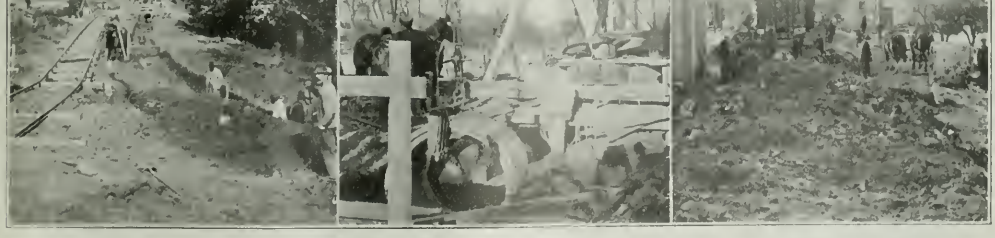
The most interesting part of the work so far was the tunneling operations carried out in 1916 under the Canadian Pacific and Grand Trunk railway tracks. This tunnel was commenced just northeast of Hurdman Road and was carried across the tracks for a distance of 400 ft. The average depth below ground level was 24 ft. A night and day gang were kept constantly at work on the tunnel, the progress made being 6 ft. per shift. Four men were kept laying the tile and two digging ahead, six men in all composing the gang.

The tunnel drum used was constructed of boiler plate riveted together and braced by angle iron, the "peak" (or the 8 ft. end) being placed where the "mucking" operations were carried out. This peak allowed plenty of space for the laying of the tile behind. The drum was driven ahead by screw jacks as the "mucking" operations progressed. For most of the way the tunnel was pushed through hardpan and river clay. At one portion, however, quicksand was struck and there an air blower was used which stiffened it sufficiently to allow the work to be proceeded with. This section from Somerset street to Hurdman road had an underdrain laid 9 in. in diameter.

The Lees Avenue section was constructed of 54-in. tile during 1917. Quicksand was found most of the way, and truss braces had to be used for holding up the bank. Double sheeting and the wood haunches had to be left in the trench.

The tile for the 60-in. and 54-in. sections was supplied by the Natco Tile Company at a cost of $5.65 per lineal foot.

When about a quarter of the work was done on the 54-in. section Commissioner of Works Macallum decided to call for



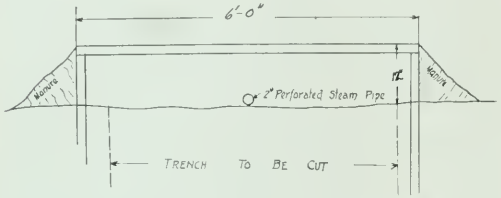
VIEWS ON CONSTRUCTION OF CONCRETE PIPE SECTIONS OF RIDEAU RIVER INTERCEPTING SEWER.
Left: Light Railway for Pipe Conveyor—Center: Lowering 3,300 Lb. Section of Concrete Pipe into Place—Right: Method of Rolling Pipe to Trench, by Team, Found More Economical than Light Railway.

tenders for reinforced concrete pipe. The tender of B. Blair & Co., of Woodstock, Ont., was accepted, at $4.34 per ft. for 54-in. pipe, and $3.44 per ft. for the 48-in. pipe. This meant a saving of $1.92 per ft. for the 54-in. pipe and $3.41 per ft. for the 48-in. pipe. This step taken by the Commissioner saved the city $19,000; $15,400 in the cost of pipe, and $3.600 in the cost of laying it.

By the end of 1917 the work had been carried as far as Main street, next to the Williams property. Further progress was delayed by a disagreement between the city and Mr. Williams over the price of a strip of land where the sewer was to be built. This dispute was settled in July, 1918, and the work was recommenced in August.

Handling Pipe

The work of conveying the pipe from where the contractors had dumped them caused delays and entailed a great deal of expense. At first a track was built and a light carriage made. This was drawn by horse to the derrick but the lifting and laying of track always delayed the work of pipe laying for several days. The difficulty was overcome by providing two wheels which were inserted into the pipe and tightened by wooden wedges; through the center was a 2-in. steel spindle



THAWING BOX USED ON RIDEAU RIVER SEWER EXCAVATION.

which protruded about 9 ins. past the edge of the pipe on both sides; a team was hitched to this and the pipe drawn to the job like a large roller. With this device there are no delays in pipe laying, the work going on steadily day by day. The highest record reached in pipe laying was 124 lin. ft., the average being 72 lin. ft. per day of nine hours.

It has been decided to push this work ahead during this winter in an endeavor to finish it by next August.

Thawing Ground

To cheapen the cost of excavation during the winter months when the frost has penetrated deeply into the ground a box has been built, as shown in the sketch herewith. This is laid each night about 60 ft. in length (sufficient for a day's work). Into this box a 2-in. steam pipe is run, perforated every 18 ins., and steam is kept on at high pressure. In the morning the ground has thawed out and digging is comparatively easy.

To keep the fresh cement in the joints from freezing, two brick heads are placed in the interior of this pipe where the cement is still green and steam is kept circulating between them.

Equipment Used

The following is a list of some of the larger equipment used during construction: 1 45-h.p. boiler (steam), 1 40-h.p. boiler (steam), 1 derrick and 1 traveler, 3 syphons, ¼-in. submerged pump (electric), 1 4-in. suction pump (electric).

Cost of Materials

The costs of various materials used are as follows:

1917—54-in. concrete pipe	$4.34 per ft.
48-in. concrete pipe	3.44 per ft.
1918—48-in. concrete pipe	4.30 per ft.
30-in. concrete pipe	2.35 per ft.
1917—60-in. Natco tile	5.65 per ft.
1916—Cement	.43 per bag
1917—Cement	.52 per bag
1918—Cement	.73 per bag

Cost on 60-in. Segment Block Section

On the 60-in. Natco tile section in 18 ft. of excavation the costs were as follows:

	Lin. ft.
Excavation and backfilling	$ 8.240
Pipe laying	.375
Natco tile, including underdrain	7.427
Pumping	.766
Shoring	.652
Grading plant, sundries	1.744
Total cost per lin. ft.	$19.204
Tunnel section (excavation) per ft.	$19.37
Manholes (concrete) each	$61.46

Cost on 48-in. Concrete Pipe Section

The cost of 48-in. concrete pipe section in 4 ft., 6 ins. of excavation this year was as follows:

Labor

	Lin. ft.	
Excavation	$1.37	
Shoring	.68	
Pumping	.20	
Backfill	.60	
Culvert drains (draining property)	.16	
Rolling pipe	.29	
Running hoist	.33	
Derrick and track	.44	
Grouting	.12	
Pipe laying	.34	
Sundries (including Saturday afternoon holidays for laborers)	.58	
		$5.11

Material

Pipe (including hauling)	$3.60	
Coal	.24	
Cement	.11	
Sundries	.11	
		$4.06
Total cost of interceptor per ft.		$9.17

The above costs on the 48-in. section were taken on 400 lin. ft. of work which was done in August, 1918. On the Williams property laborers were being paid 35 cts. per hour. On this section and on the Natco tile section 1916 laborers were being paid at 27½ cts. per hour.

Work by Day Labor

The whole of the construction work was done by day labor, the assistant engineer in charge to Main street being W. F. M. Bryce (now overseas), the writer taking his place and is carrying the work to completion. Mr. F. C. Askwith supervised the work from the beginning and latterly Mr. A. F. Macallum, the Commissioner of Works.

The Rideau interceptor will cost $300,000 and the extension to the interceptor $50,000, making in all a total of $350,000.

When this work is finished another drainage scheme will require to be commenced for that part of Ottawa southwest of Leonard and south of Cameron. This will be built in the separate system, the surface water being drained into the river and the sewage pumped into the present interceptor at Leonard and Cameron. Preliminary surveys and levels are at present being made for this.

The city has expropriated a strip of land along the whole

bank of the river where the interceptor is laid: this strip averages 50 ft. in width. The intention is to build a new driveway later on to connect up with the Federal Government's driveway system.

Reclamation of Swamp Lands in Dane County, Wisconsin

By W. G. Kirchoffer, Sanitary and Hydraulic Engineer, Madison, Wis.

There are thousands of acres of swamp lands in Dane County, Wis., which have been of little value in the past for want of drainage. Up to the year 1907 little was done towards the drainage of these lands for the reason that our drainage laws previous to that time were so drawn that they did not favor the formation of drainage districts. That is to say, they gave the few, who were opposed to drainage, so much power in the matter that it was difficult for those land owners favoring drainage to organize the district and get the drainage work under way.

Fourteen Drainage Districts Organized

But, this has all been changed. In 1907 the Legislature gave us a most excellent drainage law so that now it is a comparatively easy matter for a number of farmers to get together and organize a district. Within the last ten years 14 such districts have been organized, involving the drainage of 129,349 acres of marsh and swamp lands, owned by approximately 915 farmers. These fourteen districts are all within a radius of 25 miles of Madison, Wis. The work of excavating the main and lateral ditches has been completed upon all of them except the Door Creek and the Lower Badfish, upon which the contracts have not as yet been awarded. The work on the Middleton is still in progress. The Springfield, Sun Prairie and upper Door Creek failed to organize.

Open Ditches

The work undertaken by most of the districts as an organization, or corporation has been to straighten and deepen the creek or main drainage line of the marsh under consideration, or, if there is none, to provide a main outlet. Lateral ditches in some of the districts have run from the main ditch so that each land owner has an outlet. No attempt is made to complete the work of drainage by laying drain tile, but this work is left for the sub-drainage districts to do, such as the Orchard Farm Garden and 1st addition to Orchard Farm Garden which are sub-divisions of the Starkweather District. In some cases this work is left for each farmer to do as he chooses, or as he may find it necessary to do.

The Ditches

These main ditches vary in bottom width from 4 to 30 feet, according to the amount of water they have to carry. The main ditches in the Shephard, Koshkonong and Starkweather drainage districts are the largest, that of the latter being 30 feet wide at the point where it passes the beet sugar factory into Lake Monona. The depth of these main ditches varies from 4 to 7 feet, according to the topography of the land and the distance from the outlet. The lateral ditches are usually 3 feet wide on the bottom and from 3 to 5 feet deep.

The total length of ditches in each district are as follows:

Albion	61925 ft.
Badfish, Upper	30480 ft.
Badfish, Lower	137150 ft.
Door Creek	60000 ft.
Koshkonong	152940 ft.
Medina	27085 ft.
Middleton	31969 ft.
Nine Springs	49632 ft.
Rattlesnake	107692 ft.
Rutland	25800 ft.
Starkweather	99991 ft.
Shephard	98900 ft.

The average number of feet of ditch per acre varies from 23.3 feet in the Medina Drainage District to 46.7 feet in the Albion district.

Digging the Ditches

These drainage ditches are usually dug with slopes of 1 to 1 so as to prevent their caving when the excavation is done with a dry land machine, but where floating dredges are necessary the side slopes are very steep, which is an objectionable feature of floating dredge work. In determining the amount that each land owner shall be assessed the commissioners in charge of each district look the lands over and, after reaching a decision as to what extent each piece if land will be benefited by reason of the contemplated work, levy an assessment accordingly.

Benefits

The benefits are usually based on the difference in the estimated values of the land before and after drainage. The total benefits accruing to the lands in each district as estimated by the commissioners are as follows:

Albion	$ 49,446.35
Badfish, Upper	35,728.40
Badfish, Lower	150,748.00
Door Creek	139,118.00
First Addition to Orchard Farm	33,801.00
Koshkonong	167,570.00
Medina	10,525.00
Middleton	37,577.00
Nine Springs	50,571.00
Orchard Farm Garden	50,481.00
Rattlesnake	66,816.00
Rutland	10,073.25
Shephard	87,828.51
Starkweather	147,106.00
Total	$1,037,389.51

Damages

Besides estimating the amount of benefits which will accrue to the land, the commissioners also estimate the benefits to the highways and railroads. In some cases there are damages to pay, as for instance, when dry land is taken for the right-of-way of the ditch, culverts have to be lowered, or railroad companies are compelled to open bridges to allow dredges to pass. As a rule the cost of this work does not amount to as much as the estimated benefits. This cost is usually stated as a percent of the benefits in arriving at the amount each owner should pay. This percentage varies in the different districts according to the local conditions and the judgment of the commissioners, but usually it is betwen 25 and 35 per cent.

Cost Per Acre

The estimated cost per acre in the different districts, including the cost of engineering and organization is as follows:

	Cost per acre
Albion	$ 9.26
Badfish, Upper	8.73
Badfish, Lower	19.78
Door Creek	17.41
*First Addition to Orchard Farm	35.92
Koshkonong	8.25
Medina	5.54
*Middleton	41.40
Nine Springs	12.10
Orchard Farm Gardens	24.50
Rattlesnake	4.71
Rutland	11.00
Shephard	7.17
Starkweather	10.20
Average	$12.96

*War Prices.

The large variation in the cost per acre is caused by the difference in the size of the contract, the number of lateral ditches put in and whether or not the work was done before or during the war. The Rattlesnake district has the lowest cost but it is the poorest drained. The Middleton is the highest but it has the smallest area, a long costly main ditch, many railroad crossings and the contract was let under war prices.

Contests

Besides the actual cost of the work of digging the ditches, engineer's, commissioner's and lawyers' fees and court organization expenses, to be paid, there have been contests between the districts and land owners, railways and one district with another district. Some of the districts have had very little trouble in this respect, as for instance, the Albion Drainage district located near the city of Edgerton. This district had only one remonstrance that amounted to anything and this was made by the city of Edgerton. They remonstrated because they thought the district would turn such large volumes of water into Saunders Creek that the city would be flooded, but they later changed their minds and withdrew. Experience has proven that their fears were groundless.

The larger districts naturally have more trouble than the smaller ones because of the greater number of people involved. At one time the Shephard district had 57 different farmers objecting to the work or assessment. The Rattlesnake and Koshkonong districts likewise have had much trouble. The Rattlesnake district dug their ditches first with the ideas of draining into the Koshkonong ditch when it was dug. The commissioners of the two districts could not agree on the amount to be paid by the Rattlesnake district for the benefit they would derive from the excavation of the Koshkonong creek so the case was taken into the courts where it was fought for several years. A decision was granted in favor of the Koshkonong drainage district by the Supreme Court. The court expenses were more than the assessment levied.

Seven Foot Pond Changed to Corn Field

The benefits received by proper drainage are indeed great and there can be no doubt as to the feasibility of draining marsh lands when the fall is sufficient to warrant it and the soil contains the proper ingredients for the production of crops. Already in the short time that this work has been under way, corn has been raised where a few years ago there was a pond of water 7 ft. deep and this without intensive drainage.

Secondary or intensive drainage has only been taken up in a large way within the last three years.

Tile Drainage

The Orchard Farm Garden District, a sub-drainage district created out of the Starkweather district was the first to organize and has an area of 680 acres and is tile drained with 4, 5, 6 and 8 in. tile into the ditches of the Starkweather drainage district. The lines of tile are spaced 8 rods apart and the shallowest depth is 3 ft. Where possible a fall of 1 ft. in 1000 ft. is used. The majority of the area of the district has been under cultivation for the past two years.

Crops

The first year the owners (real estate men) put the plowed portion into sugar beets but this last season it was rented out for truck garden purposes, in tracts of 10 to 15 acres each. The rental was $15 per acre. One gardener put 15 acres into onions which yielded about 600 bushels per acre. This subdrainage district appeared to be such a success that 19 other landowners in the Starkweather district got together and organized the First Addition to the Orchard Farm Garden Drainage District. The spacing of the tiles in this district was the same as in the Orchard Farm Garden, but no 4 in. tiles were used except on a small tract where the spacing was 66 ft. These tile were all laid with a depth of 3½ ft. at the upper end and a fall of 1 ft. in 1000 ft. except a few main lines which were laid as flat as 0.6 ft. per 1,000 ft. The soil in the first Addition is principally clay and sandy loam whereas that of the Orchard Farm Garden is principally peat. It is nearly all underlaid with sand or gravel.

Personnel

Nearly all of the engineering work on these districts has been done by engineers located in Dane County. Besides the writer, Mr. P. H. Hintze, County Surveyor has acted as engineer for the majority of the districts.

The work of managing the affairs of these districts demands the services of men who have had experience along drainage lines. Mr. George E. Brown, of the Town of Burke is acting as commissioner on the Koshkonong, Starkweather, Nine Springs, the Middleton, Door Creek, Lower Badfish, Orchard Farm Garden and 1st. Addition to Orchard Farm Garden Drainage District and is now making a specialty of this work as the duties of Secretary on all of these districts require all of his time.

Prospective Work

All of the work now under construction, or which has been planned, will be done inside of three or four years when the benefits secured by the draining of land can be seen by those who at present have not faith in its ultimate success.

Performing Municipal Construction Work by Day Labor in Flint, Michigan

By Ezra C. Shoecraft, City Engineer, Flint, Michigan

The Charter of the City of Flint requires that all work which is paid for by special assessment shall be advertised and that bids shall be solicited; but it is left to the judgment of the Common Council as to whether the bids are satisfactory. If the bids seem too high or if they are unsatisfactory, then the bids may be rejected and the work done by day labor, said Mr Shoecraft in addressing the annual convention of the Michigan Engineering Society.

Sewers, Pavements, Sidewalks

Sewer construction by day labor was begun in a small way in 1910 with very satisfactory results. This happened to be a segment block sewer, the first sewer of this kind of material ever constructed. During each succeeding year, small sewers were constructed until the year 1915 when the city undertook the entire sewer program. The city has done all sewer work by day labor since that time.

Sidewalks by day labor were begun in 1912 and have been so built since that time.

The day labor plan for pavements was begun in 1914. During that year 2.36 miles of concrete pavement were constructed. In 1915 all of the pavements were built by day labor, and except for a small amount of asphalt block pavement laid in 1917 all of our pavements since that time have been put in by day labor.

The construction of pavements, sewers, and sidewalks by day labor under the direction of the City Engineering Department in Flint started very much like Topsy, "It just happened."

The organization of our department is very different from the ordinary City Engineering Department, for the reason that we must, in addition to having men qualified to design, have men who are capable of directing work and handling men. This is a huge problem for the reason that men who are so qualified are very much in demand and contractors are continually on the lookout for them.

Volume of Day Labor Work in Flint

To give some idea of the volume of the work done by day labor by our department, note the following:

	Miles of Sewer	Miles of Pavement	Sq. Yds. of Pavement	Miles of Sidewalk	Sq. Ft. of
1910	0.23				
1911	0.86				
1912	.35			1.73	45,582
1913	5.12			5.02	132,620
1914	3.0	2.36*	19,381.4	9.5	250,800
1915	21.2	7.0	85,522	7.2	191,000
1916	20.55	8.39	109,070	17.5	462,000
1917	26.59	8.27	139,423	16.7	452,736
1918	15.06	3.92	52,106	13.68	361,540
	92.96	29.94	405,502.4	71.33	1,896,278

*Concrete.

Construction Equipment Owned by the City

To do this work we have the following equipment. No mention will be made of small tools:

For Sewer Construction: 1 Austin excavator capable of excavating a trench 15 ft. deep and 36 ins. wide; 1 Parsons excavator, capable of excavating a trench 20 ft. deep and 60 ins. wide; 1 Potter sewer machine for large sewers; 1 Parsons backfiller; 2 600-gal. Novo trench pumps.

For Pavement Construction: 1 Type O Thew revolving steam shovel; 1 Model 14B Bucyrus revolving steam shovel; 2 Coltrin concrete mixers for curb work; 2 14-ft. Milwaukee batch concrete mixers for foundation work; 1 10-ton Kelly Springfield road roller; 5 2½-yd. Troy asphalt wagons; 1 Hetherington & Berner asphalt plant capable of manufacturing mixture equal to 1,500 sq. yds., 2 in. A. C. surface in 10 hrs.; 1 8-ton Austin tandem gas asphalt roller; 4 G. M. C. 5-ton trucks with steel dump bodies; 1 Nash 2-ton truck; 1 Haiss wagon loader; 6 Studebaker dump wagons; 1 Byers auto crane; 1 Gravel pit equipped with Sauerman drag line.

For Sidewalk Construction: 2 Coltrine concrete mixers for cement work; 8 wheeled scrapers for grading purposes.

To the above equipment may be credited to a great extent the success of day labor work in Flint. This equipment is put on each separate job on a per diem basis, and is entirely self-supporting. Each year each machine is given proper depreciation.

Relative Costs

Naturally you would like to know relative costs. Relative costs of this city to any other city are of no value unless all of the items entering these costs are taken into consideration.

The last bids that we had for pavements was in 1915. That year our asphalt plant laid our pavements for $21,000 less than the same pavements would have cost had we accepted the lowest bid. The original cost of the plant including roller, wagon and small tools was approximately $15,000.

We have, however, compared our costs on all of our different works with other cities and we find our costs very satisfactory.

Concrete Bridges Built by Contract

We have in the past five years built a number of new concrete bridges, and we have in each case done this work by contract. We have considered this the better plan for the reason that we did not have enough of the work to warrant us to maintain an organization for this particular class of work. Reinforced concrete bridge work is in a class by itself and needs men who are thoroughly experienced in that line of work. In addition, thereto, special equipment is usually needed for each bridge, and many times equipment which may be efficiently used on one may be entirely useless on another. If you noted the equipment which I stated above that we now operate, you will see that all of it is standard equipment which is generally usable. We have been very careful in the selection of our equipment not to buy tools which can only be applied to special jobs.

Street Cleaning

There is one class of municipal work which this department does and which should not be passed by, although it is not construction work. About one and one-half years ago the department of street cleaning was turned over to us and we have attempted to systematize it and put it on an efficient basis. We operate two power flushers, one is a 1,200 gal. Tiffin motor flusher and the other is a 1,800 gal. Mack flusher with Haiss equipment.

We have obtained excellent results with these machines and feel that our costs compare very favorably with other cities, but it is my opinion that still greater efficiency should be secured. Our costs for street cleaning approximate $.04 per sq. yd. per year. This includes pavement cleaning and snow removal. I believe that this is an engineering problem, and although I have given it considerable study I am not prepared to state at this time where I believe the greatest improvements can be made in this work. I am not satisfied as yet, that the ideal street cleaning machine has been invented.

Contract Versus Day Labor System

In the matter of day labor, I think there is a line and a very distinct line where work should be done by contract and where it should be done by day labor. It is my opinion that the small city should do their work by contract for the reason that they do not have a trained force capable of doing first class work, and it would be too expensive for them to maintain a trained force for the relatively small amount of work which the small city usually does. As regards the size of the city to which this would apply, I am not prepared to state for the reason that the size of the city does not necessarily signify the amount of work which that city may be doing. It is also my opinion that day labor does not apply to the large city of half a million or more, that is growing rapidly and doing extensive public work. The reorganization that is necessary to carry on such work is too cumbersome.

Conclusion as to Success of Day Labor in Flint

We believe, however, that in our city that the work by day labor has been satisfactory, that as a whole our costs have been less than they would have been by contract; that we get equally as good and generally better work done; that we have the work done more expeditiously by this method; that we give the property owners affected by any improvement, more consideration than the contractor does; that urgent work is given preference and done first; and, that better work can be done and the incentive to cheat is removed.

Dunn Wire-Cut Lug Brick Patents Sustained

The Dunn Wire-Cut Lug Brick Company of Conneaut, O., has been given the decision by the United States Circuit Court of Appeals of the Sixth District in its suit against Joseph Nicholson et al. of Toronto, Ohio, for infringement of patent. The court affirmed the validity of the Dunn patent on wire-cut lug paving brick, and states that an injunction should issue against Nicholson restraining him from making or selling the brick claimed by the complainant to be an infringement of the Dunn patent, and an accounting should be made by Nicholson to the Dunn Wire-Cut Lug Brick Company. This decision sustains every claim made by the Dunn Company.

The case has been in the courts for two years and the result is of interest to the paving brick industry, as wire-cut lug brick are being made by 48 companies, operating 72 plants in 12 states.

The suit grew out of the making and selling by Joseph Nicholson et al. of Toronto, O., of a wire-cut brick having lugs cut with a knife instead of wires. The Dunn Company sued Nicholson for infringement, claiming the Nicholson brick was a wire-cut lug brick within the meaning of the law and the understanding of the trade.

The Circuit Court of Appeals sustained this contention. It held that the Dunn brick was a new and useful invention; that the general use into which it had come aided establishing its character; that it was a better brick than other wire-cut brick and was produced by a simple means; that the invention was protected by a basic patent; that the method of cutting the

lugs made no difference, since whether the cutting be done by wire or knife or saw the methods are equivalent, and the Dunn Company is entitled to the protection of equivalent methods. A cutting wire, says the court, acts like the cutting edge of a knife and the cutting edge of a knife is, for this purpose, a wire; hence, all such brick, whether sliced by wire or knife or saw are in trade universally known as wire-cut brick; that Dunn's patent entitles him to the breadth of equivalency pertaining to an invention of that character; that the inventor may have a patent which covers the invention and gives a monopoly upon it regardless of great variations in the method of making; that the knife used by Nicholson was the perfect equivalent of the wire bent to the same form, and in the true sense of the patent cutting lugs by knife or saw or any other device sweeping through the clay is an exact equivalent of the Dunn method, and is therefore an infringement.

Both the Circuit Court and the Circuit Court of Appeals concurred in the finding regarding the Dunn Wire-Cut Lug brick that "the demand for this brick, following the test of actual service was such that the output rose from 2,233,000 in 1910 to 138,000,000 in 1915.

Economic Value of Electrically Driven Pumps for Small Water Works

By D. D. Ewing, Professor of Electric Railway Engineering, Purdue University, Lafayette, Ind.

The great development in motive power and power pumps within the last half century has placed the possibility of a reliable water works system within the reach even of rural villages. The period 1885 to 1905 saw the installation of public water works in many small towns. At that time about the only pumping power available was the familiar steam plant, consisting of a steam boiler and a reciprocating steam pump. Many of these plants have lived out their allotted days and the question of replacement is becoming a rather common one, said Professor Ewing in addressing the annual convention of the Indiana Engineering Society.

Within the last 15 years, several new types of pumps have been developed to a high state of perfection. This is true also of the electric motor. A study of water works statistics reveals a rapidly growing tendency to replace other pump motive powers with the electric motor. The subject of this article, therefore, is of pertinent interest not only in an academic way to engineers, but also in a highly practical way to municipal authorities, electric central station utilities, and manufacturers of pumping and power equipment.

Advantages of Electric Motive Power.

As practically all forms of so-called "power" pumps—centrifugal, rotary and displacement—can be adapted to electric drive, the questions arising relative to the application of electric motors to municipal pumping are those pertaining to first cost and operation rather than mechanical design. In brief the advantages commonly claimed for electrically driven pumps are:

Lower first cost
Lower operating expense
Greater compactness and simplicity
Require less attendance and are more convenient than other forms of drive.

Where water is pumped from widely separated wells electric drive is particularly advantageous. Pumps so driven may readily be arranged for automatic operation starting and stopping automatically at pre-determined pressures on the discharge mains.

The energy required by electrically driven pumps is usually expressed in kilowatt-hours per 1000 gals. of water pumped. This is not a very satisfactory duty unit as pumps work between wide ranges of suction lift and discharge head and their energy requirements, therefore, differ greatly. For large low head pumps the energy requirement may be as low as 0.4 Kw.-hr. per 1,000 gals. and for small high head pumps as high as 10 Kw.-hrs. For average conditions 1.25 Kw.-hrs. per 1,000 gals. seems a fair figure. The energy cost, of course, depends on the electric rates and they too vary through a wide range being dependent on size, kind and location of the central power station. These rates usually contain a demand charge and an energy charge both graded as to magnitude of the customer's requirements. A rough average flat figure for small stations is of the order 5 cts. per kilowatt-hour. For larger stations 2 cts. per kilowatt-hour is probably nearer the correct average.

Possibly the greatest objection that has been urged against electric drive is lack of reliability. This objection is based largely on the fact that the electric motor is not a prime mover but is dependent for its energy supply on transmission lines and the central station. As a matter of fact, however, for a small pumping plant consisting of but a single unit the electric drive is the most reliable of all power drives. The motor itself, if properly applied, is more reliable than either steam or internal combustion engines and the transmission line and central station are more reliable than is a single boiler.

Power Requirements

The engineer who applies an electric motor to a given drive must have a very accurate knowledge both of the characteristics of the motor and pumps and requirements of the drive if the application is to be successful. Too often the electric drive has been condemned as inherently defective, whereas, the defect lay in the application and not in the drive itself. The requirements in water works service are rather numerous, although in the main they are not difficult to meet.

As far as power driven pumps are concerned, waterworks systems may be classified as (1) direct pumping (2) pumping to storage (3) combination of the two systems. With the latter system it is not uncommon to shut off the storage line during a fire and pump directly into the mains at some higher pressure.

Several types of pumps are available and in general pumping can be classified into deep well and surface pumping. The latter class includes all of the suction lifts low enough to permit the pump being placed at the ground surface.

For deep well pumping displacement, centrifugal, propeller and air-lift pumps are in common use. No attempt is here made to discuss in detail the problem of pump application to a given service, rather it is to limit the discussion to the requirements of different types of pumps from the standpoint of the application engineer. For the displacement pumps, that is those using a plunger or a piston, a pumping head to change the rotary motion of the motor to the reciprocating motion of the pump is necessary. This head must be geared to the motor because the lowest economical motor speed would still be far too high for the pump. Centrifugal and propellor pumps for deep well pumping are driven by direct connected vertical shaft motors. Obviously the motor and pump speeds must be mutually adapted and this requires care on the part of the pump manufacturers. Alternating current motors are most commonly used in small municipal plants and their speeds are fixed depending on the number of poles of the motor and the frequency of the alternating current. For the common frequency of 60 cyles the standard small motor speeds are 1800, 1200, 900, 600 and 450 revolutions per minute. In connection with air-lift pumps motors may be used to operate the air compressors.

Surface Pumping

For surface pumping displacement, centrifugal and rotary pumps are used. Until recently displacement pumps had the field pretty much to themselves. Because of lack of understanding of its characteristics, the centrifugal pump has gained, in some quarters, the undeserved reputation for trickiness. The modern centrifugal pump correctly applied is

really an extremely reliable piece of machinery because of its high speed and favorable operating characteristics is particularly well adapted to motor drive. Its efficiency is usually somewhat lower than that of well designed displacement pumps. In a line of modern pumps ranging in capacity from 200 to 2,000 gals. per minute at 100 ft. discharge head, the efficiency ranges from 60 to 77 per cent. These figures are much higher than those secured with some of the older designs.

The output rating of an electric motor is limited by the heating of the motor windings. The rating assigned by the manufacturer is that output which the motor can carry continuously without over heating the windings. Because of this heating limitation, some care must be taken in selecting a centrifugal pump which is to be mated to a motor.

If the head against which a centrifugal pump is discharging is gradually increased, the discharge lessens until finally at a head fixed by the design of the impeller, it ceases and the rotating part of the pump simply churns the water in the casing. Under these conditions that pump requires only a fraction of the power required when delivering rated discharge. The valve in the discharge line of such a pump may be closed, therefore, without endangering either the pump or the motor.

If now that head be slightly decreased the pump will start to discharge and the power required by it will increase. For a pump of suitable design for operation with an electric motor the curve showing the relation between head and rate of discharge should be comparatively flat until rated discharge is reached. Thereafter the head should decrease rapidly. Such a pump is said to have a drooping characteristic. As the power required to operate the pump decreases as the head decreases the possibility of seriously overloading the motor, in case of a break in the water main, is avoided.

As protection to the motor where displacement pumps are used, suitable safety valves must be provided in the discharge line to prevent the pressure from being built up to a dangerous value when the demand in the pump is low. Displacement pumps are not as well adapted to direct pumping as the centrifugal type is.

The motors best suited for pumping service are the three-phase, squirrel cage induction motors for alternating current and the shunt motor for direct current. The alternating current motor is extremely rugged, simple and reliable, has no moving electrical contacts and may be secured with moisture proof windings. Both types of motors and all well designed high speed centrifugal pumps are equipped with ring oilers and will run continuously for long periods with only occasional inspections.

In addition to type of pump the application engineer must know the required discharge, the total pumping head, the kind of electrical energy available, whether direct or alternating, and if the latter, the frequency. The total head is fixed by the suction lift, the pipe friction, and the discharge head. Working pressures vary widely in different towns. For ordinary service the common range is from 30 to 50 lbs. per sq. in., while for fire service, pressures ranging from 50 to 100 lbs. per sq. in., are in common use.

The following actual examples illustrate in a general way the motor application problem. The figures are of the pre-war period, the example chosen being considered rather more typical than one in which the present fluent cost and labor conditions would be involved.

Concrete Illustrations

A town of 2,500 population has a steam pumping plant which has been in service for 20 years and is now about ready for the scrap pile. The direct pumping system is employed and funds are not available for the erection of a standpipe or tank. Three-phase 220-volt, 60 cycle power of high reliability is available. The ordinary working pressure is 40 lbs. per sq. in., but for fire protection purposes, 65 lbs. per sq. in., with enough capacity behind it to furnish two 1½ in. nozzles is desired. At this pressure two such nozzles will discharge about 400 gals. per minute.

Meter readings of the domestic requirements were taken during two summer periods, one of 6 days in August, the other of 15 days in September. For the first period the following data were taken:

		Gallons per minute	
	Discharge in	Day	Night
Day	24 hr. avg.	6 a. m.-6 p. m.	6 p. m.-6 a. m.
1	160	181	140
2	175	190	150
3	187	212	155
4	175	195	155
5	167	187	142
6	157	175	125
Average	170	190	144

The average for the second period was 168 gals. per minute. The maximum discharge noted was 240 gals. per minute. It was only of short duration. The suction lift and pipe friction were such that for ordinary pressure the total head was approximately 110 ft., and for the fire pressure 165 ft.

For ordinary service the data indicate that a 200 gals. per minute pump is large enough and for fire service a 500 gals. per minute pump. In case of fire the larger pump would be started and the smaller one shut down. Had it been a standpipe installation, a larger low head pump would have been advisable as it would have to run fewer hours per day to maintain the water level. Also, automatic starting and stopping would have been desirable. For the conditions in hand centrifugal pumps best fit the requirements and they were selected.

The sizes of motors necessary to drive these pumps may be calculated

$$\text{Hp} = \frac{\text{Gallons per minute} \times \text{total head}}{4000 \times \text{pump efficiency.}}$$

For the case in hand the figures are 9¼ and 31 hp. respectively. The nearest commercial motor sizes are 10 and 35 hp. and these were selected.

Costs

The estimated cost of changing to electrically driven pumps, including changes to the pumphouse and some suction line alterations was $3,000, the pumping units themselves costing $475 and $850 respectively. The cost of similar units today would be about twice that, the costs of a line of well designed modern centrifugal pumping units, capacities up to 2,000 gals. per minute, for 100 ft. head being given by

Cost=$850+$34 n where n=number of hundreds of gallons per minute rating

For 200 ft. heads the

Cost=$1600+$107 n

The pump costs alone can be figured from

Cost=$540+$7 n on 100 ft. heads

and Cost=$1200+$53 n for 200 ft. heads.

The fixed charges on the new installation at 15 per cent a year amount to $450 per annum. The salvage of the old steam plant actually decreased the investment a small amount, but this was not considered in the above estimate.

The estimated operating expenses of the new plant were $1500 per year. This included one sixth of the time of a water works employee who spent the rest of his time on other work. Energy for the operation of the pumps was obtainable at an average figure of 1.85 ct. per kilowatt-hour the actual rate being of the familiar sliding scale type. The estimated energy consumption per 1,000 gals. was 0.8 Kw.-hrs. and the energy cost 1.48 cts.

The average operating cost of the old steam plant for 3 years preceding the time in question was in round figures $2900 per year. Of this amount nearly 50 per cent, was fuel cost. The entire time of two men was necessary for the operation of the plant.

For the last year of steam operation the average fuel consumption was 14.7 lbs. of coal per 1,000 gals. The average fuel cost was 1.8 ct., and the average cost of attendance 1.27 ct. per 1,000 gals. With the present prices of fuel and labor the saving in operating expenses would be nearly double the $1400 per year indicated by the above figures.

Sanitation in Emergency Shipyards

By W. L. Stevenson, Late Sanitary Engineer, Department of Health and Sanitation, United States Shipping Board, Philadelphia, Pa.

The maintenance of a healthy and energetic force of workmen in the emergency shipyards was as essential to the shipbuilding program as the protection of the health of the boys who were being trained in our Army camps was to the success of our military plans.

But the shipyard worker was not subject to orders as men in the Army and Navy are, and besides the building of ships was done under contracts, most of which, especially those of early date, contained no sanitary requirements.

A Difficult Problem

When Lieutenant-Colonel Philip S. Doane was assigned by Surgeon General Gorgas, U. S. Army, to the Shipping Board to organize and be the Director of its Department of Health and Sanitation, he was therefore confronted with a very difficult problem.

The managers of the shipyards could see and understand that a well laid out yard, prompt delivery of materials, use of labor-saving devices and efficient methods of handling work were clearly connected with speed of production. But it was necessary in many cases to educate them to believe that the distribution of water by the common drinking cup, the exposure of excreta to flies, and the lack of adequate eating facilities were real menaces to the health of their workers and hence factors to be seriously reckoned with.

The splendid support given by the officials of the Emergency Fleet Corporation and the hearty co-operation so generously afforded by the civic and state health officials, together with the evident benefits to the shipyards of the work of the Department, are the main causes of the great success obtained by Colonel Doane in protecting the ship-workers against disease and maintaining them in a vigorous state.

During the early days most of the shipyards were in a state of construction for even the existing requisitioned yards were greatly enlarging their plants. The engineering side of the work was therefore more accentuated than is usual in public health work where maintenance of healthful conditions is the main purpose.

Medical Measures

It may be stated very briefly that the policies of the Department in connection with the medical side of the work included the physical examination of the workers, control of communicable diseases with especial attention to venereal diseases (if there was evidence of their prevalence), vaccination for smallpox and typhoid, provision for prompt treatment of wounds in first-aid stations, adequate medical and nursing staffs, and in the larger yards dispensaries or yard hospitals.

Influenza

When the influenza epidemic swept over the country the policy was to introduce in advance every safeguard to prevent its inroad into the yard rather than to await its prevalence and combat the scourge by curative measures. That these measures were successful is evidenced by the lower case-rate in many shipyards than in other industries in the adjoining territory.

Most of the Sanitary Engineering problems were closely related to the environment factors. Only a relatively few yards were located in towns or cities, while many of them were so situated that they were largely thrown on their own resources for many matters usually the function of a municipality to provide for industrial establishments.

Water Supply

It was assumed as axiomatic that an ample supply of clean, pure water (cooled in summer), properly distributed throughout the shipyard for drinking and washing purposes, was absolutely essential to the maintenance of health among the workers. Wherever possible, safe water from an adjoining municipality or private water company was piped to the yard. If this was impracticable, efforts were made to obtain artesian water or some other safe underground supply. Through the good offices of the various state boards of health, the quality of the water was constantly watched, and sterilization urged if there was any suspicion of contamination.

Careful investigation was made to prevent the use of a supply other than of drinking water purity in washrooms, shower baths, or any other place where men should not but often do drink. It was recognized that a thirsty workman will drink "anything that is wet" despite all the warning notices posted to the contrary.

Efforts were made to obtain the distribution of water by pipes and bubbling drinking fountains preferably with inclined jets and having a housing to prevent the drinkers' lips touching the orifice.

In a number of Southern yards the water was cooled by passing it through coils in an ice box immediately adjacent to the fountain.

It was very difficult to avoid the use of the bucket and common dipper for the distribution of water in the hulls of the ships. The influenza epidemic afforded an opportunity, however, for the installation in many yards (not provided with a system of water pipes) of covered barrels with a spigot and a

THE TWO METHODS OF DISTRIBUTING DRINKING WATER INTRODUCED DURING INFLUENZA EPIDEMIC INTO SHIPYARDS PREVIOUSLY USING BUCKETS AND COMMON DIPPERS. BARREL ON LEFT; CONTAINER ON RIGHT.

dispenser for flat-paper drinking cups attached and for use in the hulls of smaller metal-covered containers with the paper cup dispenser fastened to the side of the hull. These two methods were very reasonable in cost and proved to be convenient and satisfactory.

Fire Protection System Safeguards

Fire protection was of great importance in the shipyards and it was quite common to find two systems of water mains—one carrying water for industrial and fire-fighting purposes, and the other for drinking water. The fire mains were connected to emergency fire pumps, the suction to which was obtained from the nearby river or harbor, and hence frequently seriously contaminated. The two systems were sometimes found to be interconnected and the only safeguard a gate valve. Where fire protection did not absolutely demand the interconnection, steps were taken to make the two systems absolutely independent; but where the connection was necessary and could be accepted by the local health authorities having jurisdiction, a dual connection was permitted consisting of two

FLY POSTER USED IN SHIPYARDS BY DEPARTMENT OF HEALTH AND SANITATION, U. S. SHIPPING BOARD. IT MADE A STRONG IMPRESSION ON THE WORKERS.

check valves provided with three pressure gauges and two blowoffs for testing the tightness of the checks and also two gate valves to make possible examination and repairs to the check valves.

Collection and Disposal of Wastes

The proper collection and disposal of excreta in the shipyards were considered of almost equal importance to purity of water supply. Naturally in the haste of construction in the early days, the ordinary unscreened privy was commonly found. Another method was the so-called "drop toilet," which consisted of a sheltered seat over the water at the end of the ways.

It is very difficult if not impracticable to keep either of these forms clean, and an effort was made to have installed water closet fixtures connected to a sewer. Open-front seats were urged as a precaution against the transmission of venereal diseases.

Where it was necessary to permit the use of privies, considerable success was obtained in the prevention of odors by the use of a urinal trough which led to a separate excavation which was backfilled with broken stone or coarse gravel. This tended to keep the solid excreta drier than otherwise, and it was found that frequent application to the trench of dry earth also materially aided. Of course, these privies were thoroughly screened, ventilated, and had self-closing lids attached to the seats.

Washrooms

Washrooms, dressing rooms provided with lockers or other means for keeping the men's clothing clean and separated, and shower baths were deemed advisable and recommended, but it was realized, in consideration of the emergency nature of the work and the need for labor and materials, that these features were not of equal importance with water supplies and toilet facilities.

As a precaution against the danger of lead-poisoning, however, it was urged that painters should be provided with ample washing facilities. Troughs equipped with overhead spigots so that washing could be done with running water were preferred to the ordinary wash bowl with a stopper.

Fly and Mosquito Extermination

War was relentlessly waged against flies and mosquitoes first by measures to prevent breeding and secondly by screening.

Instructions were issued that manure from stables should either be removed at very frequent intervals and spread on fields in very thin layers or collected in fly-tight manure pits. Careful attention was given to see that all garbage was kept in covered, impervious containers and promptly removed from the premises.

In cases where flies were bred in the neighborhood of the shipyard and hence not under control of the Shipping Board, the good offices of the local or state health board were invoked and the nuisance was practically always abated or greatly minimized through their powers.

Several very large and comprehensive projects were inaugurated toward mosquito control by ditching, drainage works, and oiling. The largest project was at Philadelphia, where 10,000 acres of land contiguous to the large Hog Island shipyard were successfully drained and oiled under the general supervision of the Pennsylvania Department of Health.

In the South especially attention was given to complete screening of all living quarters to control malaria, but throughout the entire country very creditable results were obtained from efforts to secure screening against flies in eating places and food-handling establishments.

It was deemed as essential that the workers should have wholesome, clean food to eat as it is to burn proper fuel in a boiler if it is expected to develop power. Some shipyards maintained their own restaurants, others granted the privilege to someone to operate lunchrooms in the yards, while other yards lacked any eating facilities inside the property and depended upon the men going home, bringing their lunches, or obtaining it at eating places outside the gates. This made control over the eating facilities quite varied. Inspections were regularly made to obtain, where possible, the use of Government inspected meats, pasteurized milk, proper refrigeration of perishable foodstuffs and cleanliness of kitchens. Strenuous efforts were made to secure the medical inspection of all food-handlers.

Where insanitary eating facilities existed outside the shipyard gates, the remedy was found in the co-operation of the local health authorities having jurisdiction.

Several cities passed ordinances to clothe their health departments with necessary power to control in very splendid fashion the eating places patronized by the shipyard workers.

In common with many other war-time public health activities, it is believed that the work of the Health Department of the Shipping Board not only helped in speeding up the building of the yards and ships, but also served as a great educational movement to the host of workers who must have carried many of the lessons in cleanliness and personal hygiene learned in the shipyard to their homes, which will lift their homes to a higher plane of living.

American Good Roads Congress and American Road Builders' Association Convention

The Ninth American Good Roads Congress and the Sixteenth Annual Convention of the American Road Builders' Association will be held at the Hotel McAlpin, Broadway and 34th street, New York City, February 25 to 28, 1919.

Many problems of the most vital interest and importance are at the present time confronting the road builders of the country. It is proposed, therefore, to bring together those most prominently identified with highway construction, transportation and maintenance for the purpose of considering the questions of the hour.

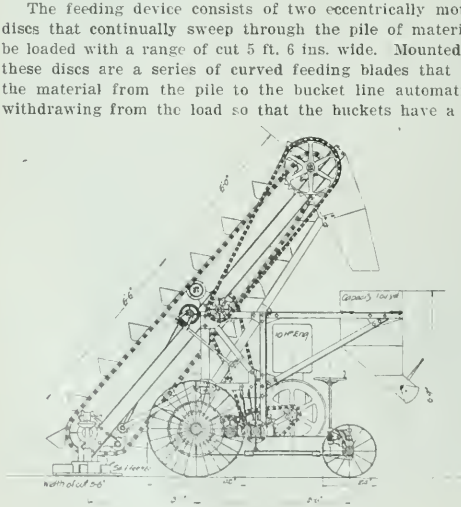
The program which is now being prepared for the eight sessions of the congress will be devoted to the consideration of highway transportation and the administration, financing, construction and maintenance of national, state, county and municipal highways. Papers by prominent highway authorities and reports on live topics by several committees will be presented for discussion. The general plan contemplates devoting February 25 and 26 to the presentation and discussion of papers and February 27 and 28 for the consideration of reports to be submitted by several committees. The business session of the association will be held on the afternoon of February 28, and the annual banquet on the evening of the 26th or 27th. It is proposed to show motion pictures pertaining to highways on two evenings during the congress.

Next year it is proposed to hold in connection with the convention the most complete and comprehensive exhibit of road machinery, equipment and materials ever seen. At the time, however, it was decided to hold this year's convention in New York City, the war was still in progress and it was felt to be out of the question to have an exhibition on anything approaching a large scale. It was therefore decided to limit this feature to the facilities afforded in the Winter Garden on the top floor of the Hotel McAlpin.

A Self-Feeding Loader

The Austin Self Feeding Loader, here illustrated, is a new development in the multiple bucket type of loader. It has a patented self-feeding device which increases the economy of operation. This device enables the owner to dispense with the two men usually employed to feed buckets on machines of this general type.

The feeding device consists of two eccentrically mounted discs that continually sweep through the pile of material to be loaded with a range of cut 5 ft. 6 ins. wide. Mounted over these discs are a series of curved feeding blades that carry the material from the pile to the bucket line automatically withdrawing from the load so that the buckets have a clear sweep across the discs for loading. These feeding blades cut through the material pile continuously forcing it into the bucket path.



THE AUSTIN SELF-FEEDING LOADER.

The elevator proper is arranged for vertical movement both for cutter adjustments and folding back in traveling for shipping clearances. The power plant consists of a 10-h.p engine hopper cooled type and operating machinery consists of a direct drive chain and gear transmission, giving elevator operation, and two speed and reverse traction. The low or feeding speed is provided for use under working conditions while the high is for traveling.

Make Good on Pavement Construction to Avoid Necessity of Making Excuses for Failure

By F. A. Churchill, Conneaut, Ohio

Finding excuses for pavements which go bad is an easy job, but at best it is satisfactory only to the discoverer. Engineers seldom have to go far to discover the cause of the failure of a pavement which is constructed of materials which ought to give good results. It may be inadequate drainage, or a soft sub-grade, or an uneven foundation, or poor grouting, or delay in getting filler in place, or negligence in rolling to an even surface, or any one of a dozen causes of defects in pavements; but while the cause may be understood by an engineer, the wayfaring man, knowing nothing about such matters, condemns the type of pavement as a failure.

Attitude of Average Citizen

The average person has no technical knowledge of road building. He judges of merit solely by what he sees. In his mind there are several types of pavement, but he allows for no variations in type. In his estimation a type is either good or bad, and he judges by superficial indications, regardless of loose specifications, improper designs or dishonest or ignorant constructive work.

Builders of roads should take into account the mental attitude and inherent rights of the average citizen whose money is spent in building roads. It is not enough that preventable causes of failure can be determined after the failure. It is the duty of road builders to learn how to overcome destructive causes, and then to adopt preventive measures.

There appears to be too much generalizing in road building and too little flexibility in designing.

Spongy Spots in Subgrade

Spongy spots or stretches may be encountered for short distances in a generally solid subgrade. In such places extraordinary care should be taken to keep moisture out of the subgrade, and often it is desirable to increase the depth of artificial foundations at such places in order to give the pavement a beam strength greater there than is required elsewhere.

Depth of Foundation Should Vary

The practice of designing a brick pavement with a uniform depth of foundation for all kinds of sub-grade is the parent of evil and the source of regret. If it be good engineering practice to design pavements for the traffic they must bear, it ought to be good practice so to design a pavement as to equalize its resistance to load and vibration stresses at all points. It is obvious that a foundation adequate for a firm and dry sub-grade may not be sufficient for a subgrade that by reason of quicksand, sponginess or excessive moisture gives little support to the foundation. It is a matter of general knowledge that few highways of any considerable length have the same kind of sub-grade throughout. This fact should be given due consideration in designing road improvements; but in practice it is customary to design for a highway the same depth of foundation for all kinds of sub-grade conditions.

An Example of Faulty Design

The folly of such design was exemplified on the Cleveland, Akron road, over which an enormous freight traffic passes.

This road, 42 miles long, was built of brick with the exception of about four miles of asphaltic concrete. About two miles of the brick section was built over marshy ground, with no greater depth of foundation there than on the firm, dry section. The result was that in the spring the sub-grade for the two miles became mushy; no support was afforded the pavement, and the 12-ton and 15-ton trucks broke through the pavement and foundation, and destroyed the beam. The asphaltic-concrete section also was broken up; but the 36 miles of brick on the better soil stood up well. A 5-inch concrete foundation was laid throughout. If the two miles of road over the low ground had been provided with a foundation deep enough to assure a beam strength sufficient to bear the truck traffic, it had been wiser and cheaper in the long run.

In some sections, especially in Northern Ohio, pockets of quicksand give considerable trouble to road builders; but designs for road improvements rarely take these weak areas into consideration. Specifications require uniform foundation for stable sub-grade and for quicksand sub-grade.

Cheap Pavements Please Taxpayers Only Temporarily

The reason for this unwise practice is not far to seek. Minimizing original cost in order to reconcile taxpayers to road improvement is the prime reason for specifying a foundation for an entire highway of no greater strength than is required for average conditions. It would be sound practice to vary the depths of foundations to suit soil conditions. That might be done in many instances without materially increasing the cost. If low, wet soil required 8 ins. of concrete foundation under the brick, high, dry, compact soil might not require more than 3 ins. of concrete foundation, or, at the most, 4 ins. of concrete for heavy traffic. As a rule, the low places are comparatively few, so that by striking an average the cubic yards of foundation would not be in excess of the cubic yardage usually specified under the uniform system.

The suggested plan would involve more detailed survey of the route than is usual, and more careful preparation of plans, but it would avert some of the major troubles which ordinary practice entails.

Give More Attention to Drainage

In connection with this provision for weaknesses in brick pavements, greater attention to drainage is advisable. Sometimes drainage in a swampy section is not a problem the road engineer can solve; it may involve a system of drainage of a large area, and in that case it is a duty for the county or the state to perform.

The gist of the matter is this: Pavements should be so designed and constructed as to reduce hazards to the possible minimum.

Engineers and others in authority owe that kind of service to the taxpayers. It requires some moral courage, and oftimes it involves some risk of popularity, to insist upon having things done the right way even at greater cost than is usual; but engineers and other officials must have a high standard of official responsibility if public money is not to be squandered on poorly constructed roads.

It is a fact to which many can testify that although the taxpayers may grumble about the cost of a public improvement, if an equivalent for money expended is found in permanancy and in satisfactory service given, the taxpayers eventually endorse the work and recognize the ability and integrity of the workmen.

Lessons Taught by Road Building Experience in Florida

By G. Robert Ramsey, Assoc. Mem. Am. Soc. C. E., Consulting Engineer, Orlando and Tallahassee, Fla.

Florida has spent, relatively, more money in the construction of roads and improved highways than perhaps any other state in the Union when productive area, the assessed valuations, the population and, last but not least, its distance from the manufacturing centers, are taken into consideration.

Early Efforts

Florida road building has gone through all the stages from the County Commissioner building dirt roads in his own district, with an occasional attempt at some other kind, to the County Superintendent with the aid of the County Surveyor whose duties up to this time had beenlargely confined to running section lines on Clay roads.

All this resulted in a certain amount of education for the officials engaged and in a short time they were inspired road builders. The taxpayer, however, had full knowledge of the cost.

Quality Sacrificed to Quantity

The promoter has also been busy and there are many miles of road that have been built, as the result of his propaganda that are pleasing to the eye when first laid but which time will prove, I fear, to have been an expensive investment for the taxpayer, even when the first cost is given full consideration. Fortunately, perhaps, many of those who were taxpayers when the roads were promoted will not be taxpayers when the final settlement is made.

The slogan has been "So many miles for so much money" and quality has been sacrificed to quantity. This does not apply to any particular type of road but to all of them. Let us briefly review the results.

Mistakes Made on Brick Highway Construction

Many miles of brick highway have been built in Florida. Unfortunately many of these roads are only 9 ft. in width. For economical reasons the brick have been laid flat and a sand filler used. No base other than the sand has been used.

Even with the utmost care being exercised in the puddling and rolling of the base, and close attention being given to the use of templates to strike off the surplus material after the rolling has been completed, soft places will develop that cause a settlement in the wearing surface. This is not all, for in many cases drainage is but a secondary consideration. Assuming that proper attention has been given this latter point, it is not long after the contractor and the engineer leave the work before the side ditches are filled up, with the result that the water table is raised and in time seeps under the brick.

Traffic then finds the soft places due to the fact that because of the narrowness of the road it is confined to a given tread and the constant pounding in the same place causes a settlement in the brick to a greater or less degree, dependent upon the solidity of the foundation and the duration of the period in which the water remains in contact with the bottom of the brick. The wearing surface remains however, and at some future day may be taken up and relaid.

Good Results with Cement Grout Filler

Satisfactory results have been obtained on a sand foundation when the brick have been properly grouted with cement. Orange County built about 10 miles of the latter type in 1914 and Seminole County completed 27 miles in 1917. These roads are withstanding the present traffic and it is believed that they will remain in good condition under considerably heavier traffic than they are now subjected to. For cheap construction the grouted brick road is the most economical for Florida for it is the only road that can be laid with any assurance of durability without a prepared foundation.

Concrete Roads

Concrete roads have been laid in Florida with variable results. It is a well established fact that there are no aggregates indigenous to the state that are entirely satisfactory.

It is not my intention to imply that there are no aggregates in the state that can be used for concrete, such is not the case, but I do mean to say that there is no material that will make a satisfactory wearing surface.

The necessity for a base in all types of construction for heavy traffic is making itself felt and it will be but a question

of time when officials who have road matters under consideration will be content with less mileage and roads of better and more lasting construction. When this time comes the limestones and flints of Florida will come into their own in the construction of the base.

There are localities in Florida where concrete roads can be built well and at a reasonable cost even with the rock for the wearing surface imported and with the further knowledge that within a certain time they will have to be given a carpet coat of tar or asphalt.

Sand-Asphalt Roads

The sand asphalt roads of Florida have attracted the attention of the tourist because of their seeming smoothness when first laid. An analysis of the construction methods will, I think, show the inadequacy of this type of construction, particularly under the specifications that have been used to date.

The usual method pursued is to specify a clay base from 4 to 6 ins. in depth with a wearing surface of from and 1½ to 2 ins., more often the former.

Construction methods vary but slightly and the usual procedure is to spread the clay and depend in a large measure for compaction by traffic. The assistance or rains is not always wished but at times they contribute toward the thorough soaking of the road which later dries out and leaves deep ruts.

Prior to the laying of the top a road machine is sent over the work just ahead and the ruts are filled in with varying size chunks. Then the roller goes over it, rides the edges of the ruts and leaves unconsolidated parts which later on will be softened up by water from the bottom with the inevitable result that the road will show just where those ruts were.

Then the hot stuff is hauled long distances, often as far as four miles, and this in uncovered bodies. Obviously one of two things must happen or are likely to happen. They must heat the sand-asphalt to a point dangerously near burning, at the plant, to get it to its destination with the proper temperature, or it doesn't reach the job at the proper heat.

As a result of these conditions many of the roads would indicate considerable age were one to judge from the number of patches, when in reality the patching is done before the road is finally accepted, little or none is done afterward until such time as the road becomes impassable.

What is true of other types of road, insofar as ditches and drainage is concerned, is true here, with the well known results from the effect of moisture on bituminous pavements.

Good Roads Coming

Florida has come to the realization of what her road systems mean to her and the roads that have been built are but the forerunners of what is to come. The road of the future will be better and of sufficient width to permit of the passing of two vehicles.

Licensed Engineers

In 1915 the Legislature recognized the growing sentiment for improved roads and created the Road Department of the state. Further recognition was taken of the fact that incompetent engineering was as responsible for poor roads as were the much maligned contractors, hence they passed a law in 1917 creating the Engineers' Examining Board. It now is necessary for an engineer who wishes to practice his profession in the state to pass the examination prescribed by this board before he can do so.

Inestimable good will come from both these laws when the county officials and the people generally realize that it is not the intent in the case of the one to usurp any of the prerogatives of the county officials, and that of the other it is the intent to protect the interests of the taxpayer insofar as they can be protected by insisting upon proper engineering supervision. Unfortunately the latter law is not broad enough in scope to prevent the operations of the combination engineering and contracting firms with their guaranteed estimates.

Old and New Style Specifications

Under old conditions the contractor was at a loss to know how to bid on work for he had the influence of rival promoters, the inexperienced engineer and his personality, as well as contradictory specifications to bid against.

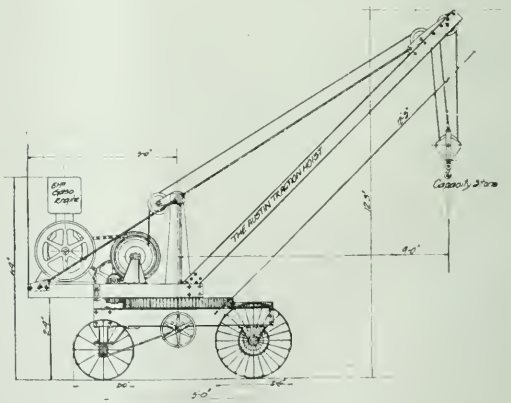
In many cases when the local engineer wrote his own specifications the result was a compilation of the most drastic points culled from specifications from all over the country without regard to local conditions and without a thought as to their possible legal interpretation.

All these conditions have tended to create discord and to discredit the engineer and the contractor as well. Be it said for the average contractor, however, that when he thinks that the engineer is conversant with the work that he is trying to handle he will as a rule meet him half way.

If the laws that have been passed are allowed to work out as they are intended to work, the State Highway Department, with Mr. W. F. Cocke at its head, will be of vast assistance to the counties of the state and there can be no question that the thoroughly competent engineers of the state, who are in private practice, will cooperate with him. Uniform specifications will be the rule, not the exception, and a contractor will be able to bid on specifications that he knows are capable of but one interpretation, he will not have to allow for the personality of the engineer, he will get fair prices for his work, and there will be more general accord between engineer and contractor.

The Austin Power Hoist

The Austin power hoist is portable. Because of its diverse utility it will be of real value to contractors. It is equipped to hoist and carry, under its own power, a load of 3 tons at a 9-ft. radius. The power plant consists of a hopper cooled gasoline engine with friction clutch controls for hoisting, swinging and traveling.



THE AUSTIN POWER HOIST.

It will be found especially useful on sewer construction, building erection, concrete paving, etc., for loading and unloading and the general handling of pipe, structural steel members, concrete carts, cars, etc. It is also useful for pulling sheet piling, for lifting excavation tubs and buckets, etc. The machine is illustrated herewith.

Rate Adjustment, Valuations, and Some of the Problems Incident Thereto

By C. M. Garland, Consulting Engineer, First National Bank Bldg., Chicago

In the operation and management of public utilities, the time has past when the management may expect to make large returns on the actual investment or medium returns on a

fictitiously large investment. The general trend of public opinion is to the effect that a public utility must first provide satisfactory service: Second efficient service, and third: That it must be allowed to make a reasonable return on the actual investment which should to all intents and purposes be a guaranteed return.

The matter of the satisfaction of the service may be left to the judgment of the public. In matters of this kind where no intricate reasoning is required, the judgment of the majority while it may be harsh is more than likely to be just. When it comes to the question of efficiency in the rendering of the service, which involves a knowledge of the details entering into the cost, the judgment of the majority is more than likely to be unjust.

Comparison of Rates

This question of the efficiency in the rendering of the service, which directly affects the cost of the service and consequently the rate to the public and the return on the investment, is one of the most difficult problems to solve satisfactorily to all concerned in the adjustment of rates. Invariably where an increase in rate is asked for by a public utility, one side or the other starts in to compare the rate of the local utility with the rate of one or more utilities in the immediate vicinity. Comparisons of this nature if not made by disinterested experts invariably work injustice to one side or the other.

Suppose for example, that the local company asks for an increase in rate and contends that this rate should be given because they are not showing a satisfactory return on their investment; this they follow up with a statement of their costs, etc., and to clinch the argument point out that the Power Companies in adjacent cities have a much higher rate and consequently it is obvious to any one that their rate should be increased.

This line of reasoning would undoubtedly appeal to the majority of the people particularly if the company had been sufficiently fortunate as to have rendered a highly satisfactory service and consequently were in favor with the people. This argument may however, be entirely fallacious and the granting of the increase in rate may work an injustice to the people. In the first place the local company may be over capitalized which would account for the low return on the investment. Again it may be, a much larger plant, or it may be serving a much more densely populated territory, or it may be serving a manufacturing community and have a much higher load factor or it may be a much more modern plant. In fact, there may be a dozen or more reasons why the local company can make its power cheaper than the companies in adjacent territories. The people served by the local company should therefore be entitled to a lower rate than the people served by the near-by plants.

Local Conditions Govern Rates

On the other hand, it might be equally unjust for the public served by the plants in the adjacent communities to say that these plants should sell power at the same rate as the local plant referred to. The point to all this is, that a change in rate must be based entirely upon the conditions existing in and about the local plant and not upon the rate made by some foreign plant. A community must pay a rate based solely upon the conditions existing in that community.

Penalty for Inefficiency

Another point that arises in connection with this question of efficiency, is, to what extent should a company be penalized for its own inefficiency and short sightedness? It is obvious that the public should not be made to pay for all kinds of inefficiency on the part of the company. Where the inefficiency lies in the operating and not in the equipment, and where the extent of the inefficiency is sufficient to show a proper return on the investment without an increase in rate, providing this inefficiency is eliminated, no increase in rate should be granted. If the improved efficiency is not sufficient to show a proper return, an increase in rate should be granted.

Where the inefficiency lies in the equipment the solution is not so simple. The faulty equipment may be due to mistakes in selection, to the company's lack of foresight in buying, or to the use of equipment which has outlived its period of usefulness. It has been the writer's custom in the first two cases to let the company stand part of the loss due to its errors and the public stand the remainder. This might not seem on first thought to be fair to the public, yet it must be understood that there is always a possibility of error in the selection of equipment and that the operating economy is not always as great as expected.

Where the company is permitted only a reasonable return on the investment, it is fair that the public should share in the hazards of the business.

War Hits Water Gas Companies

An interesting example in this connection is that of the Gas Companies who found themselves equipped with a large proportion of water gas apparatus when the war came on. The cost of enriched oil jumped from around 3½ cents a gallon to as high as 10 cents and coke in about the same ratio. This raised the cost of delivering water gas to the holder from about 30 cents per M, the pre-war cost, to something like 60 cents per M. Coal gas however, could be produced even under war conditions at about 35 cents per M delivered to the holder.

The use of carburetted water gas equipment has been common in the past so that it could not be said that these companies were at great fault, yet they found themselves greatly handicapped by the water gas equipment. They could not hope to compete with coal gas so that they were under the necessity of asking for a large increase in rate, much larger than was demanded by the coal gas companies operating possibly in adjacent communities. In cases of this kind the companies operating the water gas equipment were entitled to a sufficient increase in rate to allow them to do business and show a moderate return on their investment.

Depreciation and Obsolescence

Where out of date equipment is being used and poor economy results in a demand for an increase in rate, or where the company has been making a fair return on the investment with this equipment, but changes in market conditions have lowered this return and an increase in rate is necessary, the company should clearly replace the out of date equipment. If the company has been properly managed there should be a sufficient reserve to replace this depreciated equipment. Unfortunately there are very few plants that have maintained any adequate reserve for depreciation or absolescence. During the past few years many of these plants have found their net returns cut down to such an extent by increases in cost of labor and materials that they could scarcely pay the interest on their indebtedness. If they had had modern equipment there would have been no occasion for their financial embarrassment. In such instances the community has been forced to grant a temporary rate increase sufficient to let the company pay the interest on its obligations and sufficient additional to enable it to raise sufficient money to replace the depreciated equipment.

Over-Capitalization

The failure to provide an adequate reserve fund for depreciation is really a means for the bringing about of an over capitalization. For example, suppose a gas company owns a retort house originally costing $250,000, this equipment has been in service for a number of years and is now out of date, inefficient, and in such a poor state of repair as to make replacement neccesary. The company has carried no reserve for depreciation to speak of. When the proper time arrives it states that it requires money for extensions and borrows $500,000, half of which is required to replace the old retort house and the balance for actual extensions necessary to meet increased capacity demand. The company still carries the original investment of $250,000 for the old retort house and $500,000

addition for the new extension. Obviously the company has been over capitalized by $250,000.

In cases of this kind where no reserve is maintained the stockholders receive not only their dividends on the investment, but also their principal in the form of dividends. It is clearly the duty of the engineer in making his report to charge off the depreciated equipment.

After the question relative to the efficiency in operation come the questions of the value of the property and as to what may be considered a reasonable return on the investment.

Valuation

The question of valuation involving such items as depreciation, appreciation, obsolescence, going value, franchise value, organization expenses, etc., is one promoting endless argument and ultimately must be settled by compromise.

The items of depreciation, appreciation, and obsolescence can be very closely estimated for different parts of the plant so that it is entirely practical to set aside an adequate reserve fund for the purpose of replacing depreciated equipment. This seems to be the only practical means of preventing over capitalization of an enterprise which is required to operate with a reasonable return on the investment.

Rate of Return and Going Value

In the case of a Public Utility permitted to make only a fair return on the investment, say 6 or 7 per cent. for dividends, and from 2 to 4 per cent. for a depreciation reserve, it must be held that such an institution has no, "going value." Such items as advertising, and the promotion of sales, should be considered as operating expenses and not as a part of the capital charge. The situation is entirely different from that of an industrial undertaking, whereby money spent in advertising and in the promotion of sales has resulted in the building up of a business paying large returns on the investment. In many instances Public Utilities have practically a monopoly of their business. If the original company is therefore permitted to pay only a reasonable return on the actual investment, and this company sold out and required its successor to pay any appreciable amount as a "going value," the successor would either have to be content with a return on the investment less than what was considered reasonable for the original company, or the community must grant an increase in rate sufficient to pay the interest on this, "going value." Where the return on the investment approaches the legal rate of interest assuming that the management is efficient, there is no "going value," to sell.

Franchise

In the case of the franchise, if this has been granted to the original company without payment of any kind, and solely with the understanding that the company must be in position to supply power, gas, or water as the community requires, clearly no capital charge should be allowed. This is true even though the original company has sold out its rights and obtained from its successor a large amount for the franchise. If a value were allowed for the franchise in the valuation of the property of the successor, the public would be charging itself for something which it originally gave away. The conditions are different, however, where the company has paid the community for the franchise in any way whatsoever. In cases of this kind, a value must be allowed for the franchise in arriving at the value of the property.

Such items as organization expenses in reasonable amounts and interest on the investment during construction are true capital charges and should be entered as such.

For the sake of a rate adjustment a so-called detailed appraisal involving the appraisal of every bolt and nut around the plant is not required. As a matter of fact, such appraisals are never required except for the purpose of meeting the requirements of legal red tape.

The High Cost of Appraisals

An illustration of what a detailed appraisal can be made to run into is shown by the figures recently published for the cost of the appraisal of the properties of the Peoples Gas, Light & Coke Company made by the City of Chicago.

According to these figures this appraisal has cost the City about $246,000, and the work is not yet complete. An appraisal of these properties is without doubt a large undertaking, but $46,000 is sufficient to make an appraisal as accurate as an appraisal can be made.

Large volumes of figures covering every item in the plant may indicate a very high degree of accuracy to the legal or lay mind. It is quite likely, however, that these figures in so far as the total value of the plant is concerned are absurdities. Unless the actual cost figures are available, the appraisal of any plant is only an estimate. Every detailed item in the plant from the nails in the shingles up may be accounted for and appraised with great exactness; but when it comes to the question of labor and the expenses of construction errors of 25 or 50 per cent. are quite likely. Large errors are likely also in estimating the organization expenses, and the value of real estate.

The decision as to whether the valuation of the plant shall be based on the actual construction cost, the reproduction value today, or the average reproduction value for the last ten years, again raises a question as to the value of the detailed appraisal.

Where the original plant costs of a property are not available, a careful appraisal should be made. And after this, the company should be required to bring this appraisal to date at the end of each year.

The return on the investment should be such as to permit of the paying of dividends equivalent to 6 or 7 per cent. on the investment, plus from 2 to 4 per cent. for a depreciation reserve. This return should be practically guaranteed to the company by the community which it serves so long as the company is efficiently managed and operated. In times like the present, where prices are rapidly fluctuating, thereby varying the return on the investment, there should be some automatic arrangement for the adjustment of rates in accordance with the net earnings so that the community will not be burdened by expensive rate investigations and the activities of the company curtailed by the fear of a deficit in their working capital.

Proposed Eighteenth Street Bridge, Des Moines, Ia.

K. C. Kastberg, city engineer of Des Moines, states that the present 18th street bridge in that city is about 25 years old and has been badly neglected. Traffic conditions at the time the bridge was built were very different from those now obtaining. At the present time there are traffic restrictions on this bridge.

Ten and 12 ton loads have badly stressed the trusses in the old bridge. The floor wears out every 12 to 18 months and this costs the city yearly $3,000 to $4,000 to maintain.

Interesting points of design have arisen, the location has been discussed, and at a recent conference it was partially planned to build the new structure on the site of the old one and to erect a temporary one to take care of traffic during construction. The bridge will be about 1,000 ft. long and will be built high enough to afford head room for the railroad tracks. The north end will probably be of three-span deck girder construction and the balance of arch design with open spandrels.

The roadway will undoubtedly be built wide enough to provide room for street car tracks since the south side is developing to such an extent that it will soon require a car line there. The structure will cost in the neighborhood of $300,000 to $350,000. The Town Planning Committee is somewhat optimistic in planning what may occur in this district. Such problems as diverting the Raccoon River and straightening bad railroad curves may involve the expenditure of four to four and one-half million dollars in developing this district.

EDITORIALS

Road Construction in 1919

At the beginning of the construction season the outlook for road construction is very good. The U. S. Department of Agriculture estimates that expenditures for highway work this year are likely to amount to a half billion dollars or even more. On reports received from state highway departments the Bureau of Public Roads recently estimated an expenditure for roads and bridges of $385,000,000, or $110,000,000 more than the average expenditures for 1916 and 1917. To this figure must now be added immediately $50,000,000 and $75,000,000 more on July 1 from Federal funds. The last two figures given refer to sums made available by an extra appropriation of $209,000,000 in the Post Office appropriation bill recently passed by Congress and signed by the President.

David F. Houston, Secretary of Agriculture, considers the status of road work in the various states and the good roads sentiment highly encouraging. In addressing the representatives of 27 eastern, southern and middle western state highway departments, the Secretary recently declared his belief that highway work should be resumed immediately, notwithstanding the present costs of materials and labor, and that such a procedure would be the cheapest thing in the end for the country at large.

More than 100,000 men will be employed on active road work and there will be many thousands of others employed in the production and distribution of road building materials.

The Construction Season is Here

Since the signing of the armistice there have been great hopes of extensive construction operations to be undertaken in 1919. The eyes of the construction industry have been turned toward the opening of this construction season with that intent expression worn by those who watch and wait for the morning. Now the construction season is here and it is time to start construction operations in all parts of the country.

There is always a tendency to get the construction season "off center." This tendency is especially familiar to all who have worked on railroads. On railway construction there is usually a much belated and frenzied start which necessitates expensive and doubtful construction work at the other end of the season. The railroads are not the only offenders in this particular but they are, perhaps, the greatest offenders and, having no friends, may safely be cited.

The tendency toward procrastination in actually starting construction will be rather more pronounced than usual this season, it is feared. Added to all the usual excuses and reasons for wasting good construction days in the spring we now have the high cost of labor and materials. Unquestionably, many local authorities are holding back on account of present prices and will continue to do so until forced to act or until convinced that prices are not artificially high. Some of these local authorities must be convinced that prices will not soon come down and may even get higher than at present before starting downward toward the pre-war level. The sooner this conversion is experienced the better for all concerned. The most important, and perhaps the most difficult, duty now confronting the construction industry is to convince some public officials that there is no profiteering in the materials of construction. This can be done and it must be done or many improvements will be still further postponed.

There is no reason to suppose that prices will come down this season. They may not come down for five years, as was the case following the Civil War. Meanwhile, the frost is about all out of the ground. Now, if ever, is the time to start construction operations.

Local Politics and Prices

It is asserted by one observer that some local authorities, with a tender regard for their political fortunes, hesitate to build at present prices fearing that the opposition will make political capital of such a use of public funds. If, and where, this condition obtains the timid official will need do no more in self-defense than marshal a few of the available facts. Almost every important official in the executive branch of the federal government has urged immediate construction at present prices. That should be sufficient backing for any local official.

It should also be recalled by the hesitating official that all prices are high now and that the increase in costs of construction are less than the increase in cost of almost everything else. Construction prices before the war were too low. Many engaged in the industry were losing money and have just found it out. Improvements are cheap even at present prices when benefits are considered.

It is just as patriotic to build now as it was held to be patriotic to refrain from building during the war. Every economist of note urges extensive building now as the only known and approved method of keeping labor profitably employed and contented. With all the unrest there is among the laboring class throughout the world today it is a risky thing to keep men in idleness because prices are higher than before the war. It is a poor politician who can't defend himself for building now.

A Well-Considered Engineers' License Law

It is high time for engineers to give careful thought to all proposals having to do with the registration and licensing of engineers. This is true because this matter is rapidly assuming definite form; the period of flux is drawing to a close. A very few years ago this was one of the topics of discussion which did not promise to become more than something to talk about. That much progress toward licensing engineers has been made is unmistakably indicated by the fact that such license laws were recently introduced in the state legislatures of California, Colorado, Michigan, Mon-

tana, Ohio, Oregon, Iowa and Indiana. From this it appears that those who hold opinions on this subject will do well to speak up now or forever hold their peace.

The American Association of Engineers has made good, as usual, by offering a well-considered license bill for the guidance of the profession. The bill appears in the March issue of the Monad, the organ of the Association, and those interested can, and should, obtain a copy.

The bill is the work of the committee on legislation of the Association. Mr. L. K. Sherman, chairman of the committee, was especially well fitted, by training and experience, for the task of drafting the bill. To a great extent this is a combination of bills that have gone before. About fifteen existing and proposed licensed laws were examined, and the recommended bill embodies all the features recognized as essential in the existing laws.

The bill impresses one as being entirely fair to the competent engineer or surveyor and in the public interest. No effort will here be made to discuss the bill in detail. The reader should obtain a copy of it and do his own discussing, which would be more to the point.

If for Railroad Engineers Why Not for Municipal and County Engineers?

At the time of writing announcement has been made of a conference at Chicago of professional engineers in the employ of railroads for the purpose of adopting a schedule of monthly salaries for such engineers. Such a schedule was recently recommended to the United States Railroad Administration by the American Association of Engineers. The suggested schedule is to come up for consideration and possible revision and adoption. It is especially interesting to note that the rank and file were invited to attend as well as the men in the higher positions. Many railroad engineers of the highest standing are co-operating with their subordinates and the Association in this attempt to improve the financial status of railroad engineers. It is understood that the Railway Administration is favorably disposed toward the proceedings. A later issue of this magazine will report the action taken at the conference.

Many of our readers have doubtless worked for railroads and, but for the grace of Heaven, still others might have done so. All will recall how securely the average railroad engineer has been tied to the tail of the capitalistic kite and how ardently he has championed private ownership and management of the railroads. Yet under government operation he gets his first view of the promised land. The surpassing beauty of the present opportunity lies in the fact, that the Railroad Administration can, if it so elects, simultaneously raise the pay of all professional engineers in railroad service throughout the country without regard to the road employing the engineer or his previous condition of servitude.

But if the railroad engineer has been in a difficult position what can be said of the position of the municipal or county engineer? The rewards of engineers in public service have been little, if any, better than those of the railroad engineer and their positions have been less secure than his. Municipal and county engineers are not only inadequately compensated for their services but they are likely, through no fault of their own, to lose their positions at any time because of the ruthless workings of the political machine.

What can they do about it? A great deal, if they will. If the American Association of Engineers can help railroad engineers why can it not also help municipal and county engineers? Perhaps it can. Has anybody sought the aid of the Association in this connection?

Entirely on his own responsibility the editor ventures to express the opinion that the Association, if urged to do so, would call a conference of engineers, engaged in public service, for the purpose of discussing ways and means for increasing the compensation of municipal and county engineers and for making their positions more secure. Is there any demand for such a conference?

Testing Attitude of Political Candidates Toward Engineers

That the practical politician has, or can be made to take, an interest in the trained engineer was recently demonstrated in Chicago.

The Chicago Chapter of the American Association of Engineers has been taking an active part in the local mayoralty election. Before the primary election the Association secured a definite statement from each candidate with respect to his views on: adequate compensation for the engineers in the city service, the employment of technically trained men for engineering positions, and the selection of properly qualified men for the sixty day appointive positions which are not under civil service regulation. Some very complimentary letters were written by the candidates in which they expressed their admiration for the qualifications and accomplishments of the trained engineer even in making the sixty day appointments. Undoubtedly the case of the engineer in Chicago has been strengthened by this simple expedient of getting the candidates to commit themselves.

The reply of Robert M. Sweitzer, at present County Clerk, is here quoted as it is typical of all the replies and more especially because Mr. Sweitzer is one who safely negotiated the primary election hurdle:

"I am in favor of engineers in the city service receiving remuneration compatible with the service rendered. As Mayor I shall be in sympathy with the scale proposed by your Association, as I have supported the scale proposed by the draftsmen who are employed in my office at the present time, and who, I understand, are members of your Association.

"As Mayor, no sixty-day men shall be appointed to technical positions unless they are technically trained men, fully capable of performing the duties to which they are assigned; and, further, it shall be the policy of my administration to hold regular examinations so that eligible lists shall be constantly posted, thus obviating the necessity of such sixty-day appointments."

Granting that pre-election promises are not always translated into post-election performances it must still be urged that a pre-election promise is much better than no promise at all. Politicians have the virtue of intense practicality and can be depended upon to advocate the cause of the trained engineer when they are made to understand it. This for the reason, of course, that the cause of the competent engineer when presented by a candidate to the public is a very dependable vote-getting device.

Building New Concrete Shoulders to Preserve the Old Macadam Roads of Maryland

By John N. Mackall, Chief Engineer, Maryland State Roads Commission, Garrett Bldg., Baltimore, Md.

The serious problem confronting a great many state highway departments and especially the highway department of Maryland is to preserve old macadam roads constructed before the coming of the extremely heavy motor traffic of today, in a manner that will amply take care of this traffic without a tremendous loss of investment in the old road.

The Philadelphia-Baltimore-Washington Road

In Maryland, the road in particular from Philadelphia to Washington through Baltimore presents this condition. This road was constructed of water bound macadam 14 ft. in width, and from 6 ins. to 8 ins. in thickness over a period of 1906 to 1910. At this time, a road of this character amply met the conditions. It, however, does not meet them today, because the road is probably long enough, but too narrow and too thin.

Macadam roads as such, it is generally conceded, will not, without excessive maintenance, stand the tremendous traffic to which this road was subjected. Therefore, there was one of two alternatives which presented themselves,—either widening the old road in a substantial manner, or constructing a new one. During 1918, the road was subjected to a tremendous amount of heavy hauling, largely by the government direct, or by contractors engaged directly in government or war work. To reconstruct this road, therefore, with any hard surfacing would mean closing it to traffic or detouring, which would have amounted to closing the road to traffic, since none of the by-roads would withstand this amount of traffic.

Concrete Shoulders.

It was decided, therefore, to construct along each side of this macadam road a strip of concrete 3 ft. in width and 8 ins. in thickness. This would give the road a width of 20 ft. which seems to be ample for this time.

The crown of these macadam roads when built was ½ in. to the foot. This crown had been maintained, so that the road had about 3½ ins. of crown, and the steepest part of the road was near the edges. Roads with excessive crown are only used in the center portion, because there is considerable danger of sliding in the gutters where the travel is on the side, so it was decided to remove some of the crown from the road at the same time it was widened. The cross section of approximately ¼ ins. to the foot was decided upon for the existing macadam, and the cross slope was made ¼ in. to the foot in the concrete. This raised the edge of the concrete above the edge of the adjacent edge of the macadam from 1 to 3 ins. The section of macadam adjacent to the concrete was brought up to present a uniform cross section with the concrete shoulder.

Procedure in Construction

This method of construction permitted of the use of the entire section of the macadam road and one shoulder during the course of construction, which gave the maximum use of the present surface during the construction of the addition. The second shoulder was never constructed until the macadam adjacent to the one first constructed had been brought up to the proper cross section.

This work was awarded to two contractors, one on the section of the Washington Boulevard between Laurel and Relay, and the other on the Belair Road between Perry Hall and Belair.

Work on First Section

The contractor on the first section used a one bag batch mixer which ran over the trench where the concrete was being placed, mixed his concrete on the ground and deposited it in place. The contractor on the second contract used a central mixing plant and transported his mixed concrete to the site, dumped the trucks approximately in the trench and shoveled the concrete in place.

Work on Second Section

The work of the second contractor will be briefly described since the method was unusual and the results extremely satisfactory. The contractor had his own quarry and crushing plant within a few hundred feet of the center of the 12 mile section. The stone used was trap rock with a co-efficient of wear of approximately 18, and the quarry was well stripped and thoroughly cleaned.

The material was passed through a revolving screen with circular openings ⅜ in. diameter. All the material except the tailings which went over this screen was used as a coarse aggregate. It was found that the material through this screen, which was used with the sand, amounted to about 25% of the fine aggregate. The sand was hauled to the site in motor trucks and carried to the bins through the screen in the same elevator which carried the stone. This made, then, a coarse and fine aggregate in two sections in the same bin.

USE OF NEW CONCRETE SHOULDERS TO PRESERVE OLD MACADAM ROADS IN MARYLAND.

Upper View Shows Concrete Shoulder on One Side Only, Belair Road Near Baltimore. Note New Macadam Adjacent to Concrete. Lower View Shows Concrete Shoulder on Both Sides on Belair Road. The Shoulder on Right Still Covered With Stone Chips.

A hopper, holding 4 and 8 cu. ft., respectively, of fine and coarse aggregate, was made so that it could be filled directly from the bin and dumped in the concrete mixer simultaneously. This insured uniform quantities of fine and coarse aggregate with a minimum of labor. The concrete was mixed for a period of one minute and deposited in dump trucks which hauled it to the job. It was found that by making concrete which contained no excess water that it could be handled extremely satisfactorily. The concrete was made so dry that when hauled to the job even a distance of 6 miles, there was no excess water on top of the load.

Advantage of Central Mixing Plant

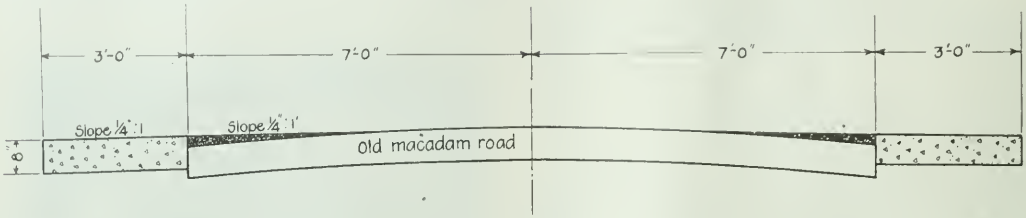
When concrete is mixed on the road in a two bag batch

mixer, 30 men are about the minimum required. By hauling from a central mixing plant, there was only required one man to see that the sand bin was filled and dumped, one for the stone, one for the cement and the engineer on the mixer. On the road 6 men shoveled the concrete in place and one man finished it. An average day's run was 800 lin. ft. of 1:2:4 concrete 8 ins. thick and 3 ft. wide.

Mixed Concrete Hauled 6 Miles Before Placing

The work was not started until September, so it is impossible to tell, from this job, how far concrete could be hauled in warm weather, yet we did haul this concrete six miles before depositing it, and the results were much more satisfactory than from concrete mixed directly on the road. This, of course, does not demonstrate that concrete can be mixed and hauled to an ordinary road job in trucks, because it is impossible to operate these trucks over the finished sub-grade. It has demonstrated, however, to the writer's satisfaction that the hauling of concrete properly mixed a considerable distance is a very feasible proposition, and when the industrial railway is substituted for motor trucks, it will seem that the same process could be used for making concrete roadway as for making this concrete shoulder.

There is hardly room for argument that concrete mixed at a central plant is more uniformly proportioned and better mixed than any concrete can be mixed on a roadway, and the writer hopes to see this method more extensively adopted in the very near future.



TYPICAL CROSS SECTION SHOWING METHOD OF ADDING CONCRETE SHOULDERS TO OLD MACADAM ROAD IN MARYLAND.

Two Types of Hard Surface Roads Successfully Employed in New Hampshire.

By Frederic E. Everett, Commissioner, State Highway Department, Concord, New Hampshire

For a good many years New Hampshire has been the mecca of thousands of summer visitors attracted hither by our beautiful lakes and mountains and it was to accommodate this increasing summer traffic that New Hampshire first broke into the road building game and for the 13 years that the department has been in existence most of our energies have been devoted toward building roads to satisfy a summer traffic.

The tremendous increase in the use of motor trucks within the last few years have brought about certain conditions, especially between large towns and mercantile centers that demand a higher class of road than that originally built and I will describe two types of pavement that have been used with success by this department.

An Asphaltic Concrete Pavement

An asphaltic concrete pavement (so-called "Modified Asphalt") has proven very satisfactory for resurfacing gravel and waterbound macadam roads over which increased traffic has necessitated a more permanent type of surface.

Topeka mixture was considered as a pavement likely to give good results with these old roads as a foundation, but the expense of grading the mineral aggregate was considered prohibitive. New Hampshire is particularly blessed with many good gravel deposits and therefore a "Run of Bank Gravel" which would approximate the mineral aggregate in Topeka was sought. A predominence of coarse aggregate led us to change the maximum size of ¼ to 1 in. Several gravel pits were located which when passed through a 1 in. screen would closely approximate the requirements. In some cases the addition of a fine aggregate was necessary but this only in small quantities. Each pit was examined with great care, tests being made every few feet around the face of the pit and by this means it was possible to find an aggregate in one section, which might be lacking in another, and by a proper combination of both the resulting aggregate would fall between the limits for Topeka.

Mixing and Laying

The gravel and asphaltic cement is heated separately to temperatures of approximately 3000 F. A revolving drum is used in heating the gravel the maximum temperature of which shall in no case exceed 375 F. at the mixer. The asphaltic cement is heated in standard kettles and shall not exceed 325 F. at the discharge pipe. The asphaltic cement is then mixed with the gravel in an approved revolving mixer in the proportion of from six to eleven per cent. and this mixing continues until a homogeneous mixture is produced, in which all particles are coated uniformly. The amount of asphaltic cement between six and eleven per cent. is determined by the voids in the mineral aggregate. The asphaltic cement used is from 55 to 75 penetration.

The asphaltic mixture is hauled to the work in tight vehicles previously cleaned of all foreign materials, and if necessary, covered with canvas of sufficient size to protect the entire load. The mixture is laid upon the base course which has previously been made to conform to the new cross-section and thoroughly rolled so as to be free from all loose material. The mixture is between 250 and 280 F. when laid. The entire load is distributed into place and raked to grade in a uniformly loose layer of such depth that after receiving ultimate compression by rolling it shall have a depth of 2 in.

Extreme care is taken to make sure that the mineral aggregate keeps within the prescribed limits. This is accomplished by "control tests" conducted whenever a change is noted in the pit, which might affect the size of the aggregate. Tests are also frequently made for the asphaltic content so as to ascertain if the percentage is being maintained.

New Hampshire has sections of this type of resurfacing (over both gravel and macadam) which have been under heavy traffic for three years and are still giving excellent results.

Used on Federal Aid Projects

The past season we have built two large Federal Aid Projects with this type of construction. The first one between the Massachusetts line and the city of Nashua, a distance of 3½ miles. In this case we were able to use the native material following the specifications as outlined above.

The second project between Massachusetts and the town of Hampton on the main road to Portsmouth a distance of 4½ miles. The gravel in this section of the State is much coarser and in order to get the proper grading it was necessary to run the material through a crusher. Everything that passed

through a 1 in. screen was used in the top pavement and the coarser material was used in a 4 in. subgrade or foundation course. It was also necessary at certain times to use limestone dust to supply the necessary fine aggregate.

Concrete Roads

The first piece of concrete road in New Hampshire was constructed during the season of 1918. A section of highway, with which some drainage difficulty had been experienced, was selected so that a test might be made as to the effect of frost action under our severe climatic conditions.

This section of road is located near the foot of a long ridge and runs nearly parallel to the crest of the ridge. This ridge makes a large watershed which presented difficulties which had to be overcome to obtain adequate drainage before concrete construction could be considered. The downward percolation of water over this entire slope was considerably retarded owing to an underlying retentive impervious stratum. In addition to the rainfall several springs were observed a few hundred feet from the road. These conditions necessitated not only drainage structures for the "run-off" but also sub-drains to intercept general seepage and lower the water table in the foundation of the road.

Sub-Drains

Several types of drains were considered but owing to natural obstacles the standard types were not thought to be efficient and a sub-drain was designed 4 ft. 3 in. deep, 20 in. wide at the bottom and 30 in. wide at the top. After the ditch had been dug true to grade, 3 in. of concrete was placed in the bottom and before initial set had taken place two flat stones were imbedded on edge in the concrete allowing a foot opening between them. As soon as the concrete had set sufficiently cover stones were placed and the remainder of the ditch filled with small cobbles. On top of these cobbles a 6 in. concrete surface gutter was constructed. Corrugated metal culverts were used to carry this surface water across the road and directly below each corrugated metal pipe tile pipe was laid to take care of the water in the sub- drain. To date the results obtained have been excellent.

The pavement itself was a 1 course concrete constructed over an old waterbound macadam, which was first scarified and shaped to make a flat sub-grade. The concrete was a 1:2:4 mix laid 16½ ft. wide, 7½ in. thick at the center and 5½ in. at the shoulders. The course aggregate, the gravel stones passing a 2 in. round opening and the fine aggregate was the sand screened from this gravel. All tests made during the work showed this sand to compare better than 100 per cent. with Standard Ottawa.

The transverse joints were made with three thicknesses of three-ply asphalt felt and was spaced 40 ft. The felt was cut flush with the surface and painted over with the bitumen.

The surface of the pavement was struck off with a strike-board or templet. A concrete roller was then used and the final finish was obtained by the belt method.

The Reconstruction of Worn Out Macadam Upon a State Road in Rhode Island

By I. W. Patterson, Chief Engineer, State Board of Public Roads, Providence, Rhode Island.

Approximately two-thirds of the total mileage of state roads in Rhode Island is surfaced with waterbound macadam which is in varying states of preservation. Plain macadam was the pioneer type of construction in the building of our state highways, as it was in many states which undertook the building of state roads at an early date. The first state roads in Rhode Island were built in 1896, and at that time and for a number of years following macadam was generally considered to be the ideal surface for surburban roads.

Early Roads Narrow

A clause in our state highway law until recently limited the width of state roads to 14 ft., not including earth shoulders, unless the towns in which the roads were located paid the entire expense involved in constructing greater widths. No compulsion could be exercised over the towns in the matter of paying for extra widths and it happened very frequently that heavily travelled roads passed through towns which did not desire or were unable to spend the money necessary for the building of roads as wide as they should have been built. The cost of the old macadams was low. The average total cost was approximately $6,000 per mile. It is apparent that this cost did not allow of extensive drainage work, or a great deal of foundation work or of heavy grading. Local rock was employed very largely in the building of these macadam roads. The character of the rock in Rhode Island varies greatly, and it happened occasionally that crushed stone of inferior quality was employed.

Traffic Changes Called for Reconstruction

The effect of present day traffic upon these narrow roads of cheap construction is so apparent that it is needless to enlarge upon the subject. It is a fact, however, that these roads carried successfully for a number of years the traffic for which they were designed and they were doubtless worth all that they cost.

Rhode Island was rather dilatory in taking steps to reconstruct the old macadam roads when the tremendous changes in character of and amount of highway traffic made such a course necessary. The financing of maintenance furthermore was so erratic that much difficulty was experienced in keeping the old macadam in reasonably serviceable condition. The accumulative effect of stopping or seriously retarding the maintenance of roads of this type we know from experience.

Reconstruction of Worn Out Macadam the Big Problem.

Reconstruction of our wornout macadam is our big problem today. The building of all of our main trunk lines was completed six years ago and this fact together with the fact that many miles of our constructed state roads are in deplorable condition causes reconstruction to overshadow in importance the building of new state roads.

This task of reconstruction was begun in earnest in 1916 and much has been accomplished since that time. There remains, however, a great deal to be done.

The Putnam Pike

The reconstruction of narrow and wornout macadam surfaces upon the Putnam Pike which is here described is typical of the work which we are doing throughout the state. The macadam upon this line was built in the period from 1903 to 1905 inclusive and was in a large part laid to a width of 14 ft. The rock employed in constructing the macadam was a coarse grained granite, some of which was noticeably kaolinized. The surface was very badly worn and out of shape. The crown to which the macadam was laid had disappeared very largely, the surface in places having a decidedly inverted transverse slope. The cross section to which the road was originally built provided in both cut and fill earth shoulders 3 ft. wide and sloped from the edge of the metalled surface ¾ in. per foot.

Foundation difficulties and imperfect drainage facilities were very pronounced upon the old road. At times in the early spring when the ground was thawing certain portions of the road were practically impassable because they became so soft. Certain sections of the road on the other hand never became soft. The traffic upon this line is heavy in character and fairly heavy in amount. It is estimated that the number of vehicles passing over the road annually at present is approximately one-half million. There is a great deal of heavy motor trucking over the road of farm products and of mill supplies and mill products. Loads weighing between 10 tons and 15 tons including the weights of the vehicles are very common, and greater loads than 15 tons are not unusual. A number of mills located near this road influence the extent of trucking over the

road greatly. The travel over the road is very uniform in amount throughout the year. During the winter and early spring there is no falling off in commercial vehicle traffic and very little lessening in the numbers of other types of vehicles. The character of the traffic over the road made necessary a very careful study of foundation difficulties and also called for a width of new metalled surface greater than the existing width of 14 ft.

Foundations

Because of the fact that the road had been surfaced with plain macadam and had been under observation for a number of years, the design of foundations was simpler than would have been the case if the road surface had been merely of earth or if the road were to be built in a new location. A careful examination of foundation conditions which had caused trouble in the past was undertaken. The most valuable information was obtained at a time when a winter thaw was experienced.

The sections which showed evidence of imperfect drainage of sub-soil or of foundation defects due to other conditions were carefully noted by survey stations. We have observed that

VIEW OF BITUMINOUS CONCRETE SURFACE REPLACING NARROW, WORN OUT MACADAM ON THE PUTNAM PIKE IN RHODE ISLAND.

it is rather dangerous to design foundations and plan sub-soil drainage from a single observation because of the fact that as a rule all of the spots which demand remedying may not show the need for special treatment simultaneously. Upon northern slopes or through a thickly wooded section the frost in the ground is slower in thawing than is the case upon southern slopes fully exposed to the sun. The effect brought about by thawing is furthermore not in evidence at the same time in soils of differing character. The thaw during which the first observation was made was not complete and was followed by severe cold weather which made possible subsequent examinations during thaws. Three complete examinations of sub-soil conditions were made, the first two of these having been made during thaws and the third having been made soon after the frost was completely out of the ground and the ground well saturated with water.

Soil Conditions

The observations from which treatment of foundation defects were planned showed that the soil conditions varied extremely. There were long stretches which showed that the soil conditions varied extremely. There were long stretches which showed not the slightest evidence of unstable sub-soil at any time. There were numerous stretches from 25 to 100 ft. long which became very soft and which rutted so deeply that traffic was endangered. A number of sections from 500 ft. to 3,000 ft. in length which were next to impassable even for light motor vehicles also were noticed. Careful notes of conditions taken when observations were carried out and a number of test holes dug later in order to make examinations of sub-soils furnished information which made possible an intelligent design of foundations and sub-soil drainage. It is apparent from the preceding description of conditions existing upon the old macadam that the adopting of a uniform cross section was not in order. Each individual defect in the old road was studied separately and taken care of in the manner which appeared to be the most feasible.

The occasional small soft spots in stretches which were otherwise free from foundation defects were found to be due to pockets of clay or of loam or to springs. Excavation of the clay or loam pockets and refilling with a coarse sandy gravel common in the vicinity was decided upon. Springs were drained to side ditches or to low points in fill.

Several relatively long stretches which were in abominable condition during thaws were upon the brows of hills from the beginning of cut on one slope to the running out of cut on the opposite slope. Ledges at the roadsides were in evidence in all of these locations. The difficulties experienced in these places were found to be due both to heavy retentive soils and to springs flowing from crevices in the ledges. As a rule, stone fill of wall and field stone laid to a V-section was laid to take care of these conditions. In excavating for these foundations bars of ledge extending almost to the bottom of the old macadam were uncovered. Our notes invariably recorded exceptionally distressing conditions immediately up-grade from these bars which of course constituted a barrier to the seepage of water in the sub-soil and which were responsible in consequence for heaving and rutting when the frost came out.

Surface Treatment of Stone Fill Foundations

The method of treatment of the surfaces of stone fill foundations in these locations is of interest. It was not deemed advisable to fill the voids in the foundation with sand or gravel, as is done frequently, because of the probability that the effectiveness of the foundations in taking care also of the flow of water from springs in the ledges would be impaired thereby. Our specifications called for grading of the sizes of stones employed for building the foundation, the smaller sizes being laid on the surface. This was not a difficult task, since the neighborhood abounds in field and wall stones of all sizes and also in chips from granite quarries. After the foundation was rolled until there was no further settlement, crushed stone passing a 1½ in. screen and retained upon a ½ in. screen was spread over the surface in quantity sufficient to fill the surface voids. Rolling was again carried out until the surface was well compacted. The object of this small crushed stone over the surface of the stone fill was to allow of more thorough compaction of the foundation than would have been possible without a filler of some sort and also to allow more free percolation of water through the foundation than would have resulted if a sand or gravel filler had been employed.

Correcting Old Foundation Defects

Very pronounced foundation defects were apparent upon the old road upon several grades which were nearly flat. Test pits dug upon these stretches disclosed the fact that loam existed a short distance below the surface of the road, although a thin layer of gravel was found under the macadam crust. The present layout of the road in large part is ancient and in the process of its development from an old trail to a graded earth road and later to a macadam all of the top soil was not removed to a sufficient depth below the surface. The fact that the grades were so flat where much of this trouble was experienced caused the flow of surface water to be retarded and induced complete saturation of the sub-soil. When thawing ensued, the results brought about by these conditions may readily be perceived. Excavation of all loam existing within 2 ft. of the surface, back-filling with clean sandy gravel and facilitating the flow of surface water by lowering of the flow lines of existing culverts so that the grades of side ditches could be increased were planned to take care of these difficulties. The obstacles to changes in the established grades of the road were so great

that such a course was not followed. In several locations where deep side ditches were not considered practicable in view of the impossibility of placing them far enough away from the metalled surface because of the narrowness of the right of way sub-drains were laid at the sides of the metalled surface in order to take care of sub-soil drainage. The placing of a number of culverts where none existed before also aided the drainage of surface water upon flat grades.

As has been stated previously, much of the old macadam evidenced no foundation defects. Examination of the sub-soil under the sections which were free from rutting or heaving in the early spring disclosed the fact that clean, coarse, sandy gravel which allowed of perfect sub-drainage was present in these locations. It was planned in these locations, therefore, to scarify the old macadam and to trench the area existing between the edges of the old macadam and the edges of the new metalled surface so that at least 6 ins. of new crushed stone might be added. New crushed stone was then spread to bring the surface up to the grade of the base of the wearing surface to be laid.

Culverts

Practically all of the old culverts were replaced. These old culverts were largely of the stone box type which was the type employed almost universally by the local road authorities of Rhode Island before the days of state road building. Some of these culverts were in all probability built more than a century ago. The side walls were of dry masonry and the top slab was formed of large flat stones. We have found from experience that it is very dangerous practice to leave in these old stone box culverts when reconstruction is carried out. It might be supposed in view of the long service of many of these structures that they would last indefinitely, but the fact that the side walls frequently are laid without proper foundations and are of rather crude construction and also because the stone slabs are subject to breaking by frost action and by impact resulting from fast moving heavy loads makes their presence undesirable. The side walls of these culverts furthermore are so irregular that debris carried through the culverts lodges very readily and results in complete stoppage eventually. The recent increase in heavy motor trucking is doubtless responsible for the failure of many of these old stone box culverts which have endured for many years.

The foundation and drainage work planned to be done in connection with the reconstruction was described in detail in the typewritten instructions to the resident engineer in charge of the work. No feature of this important work was left to the judgment of the man who was to supervise the construction because many of the conditions which required remedying were not apparent at the season during which the construction work was to be done.

The types of wearing surface selected for reconstruction were bituminous macadam and bituminous concrete. The rebuilding of the portion of the road herein described was not completed in one year as was originally planned because of the impossibility of devoting to this line the funds which would have been involved under that plan. The first section rebuilt was in 1916 and the work was extended in 1917 and also in 1918.

Bituminous Macadam Wearing Surface

The wearing surface laid in 1916 was bituminous macadam. The crushed stone employed upon this work was Connecticut Trap Rock and the binder employed was asphalt of approximately 10 mm. penetration. The crushed stone was laid invariably in two courses, the bottom course being sand-filled and laid to a grade 2½ ins. below and parallel to the finished surface. In both courses the crushed stone was of sizes passing a 2¼ in. ring and retained upon a 1½ in. ring. No bitumen was applied to the lower course of stone. The binder application of asphalt to the upper course of stone was followed immediately by an application of crushed stone passing a ¾ in. ring and retained upon a ½ in. ring. After a thorough rolling the seal coat was applied and immediately covered with clean ½ in. stone.

The crushed stone employed as a filler for the voids in the penetration course of stone was made relatively large so that the heavy seal-coat applied might penetrate between the individual stones with the result that a more perfect bond in the pavement might be secured than would have been the case if the sizes of stone employed for this purpose were so small as to result in the seal-coat forming a blanket over the surface. The character of the binder employed was such that cooling to a thick viscous consistency was so rapid as to prevent any appreciable penetration into stone of sizes much smaller than the sizes employed as a filler. The seal-coat was applied at the rate of approximately 1 gal. per square yard of surface, which is rather above the usual rate of application. The use of a relatively coarse filler, however, allowed of sufficient penetration of the bitumen into the small voids so that there has been not the slightest tendency toward softness of the surface in the hottest days of summer nor of waving under traffic. The bitumen was applied by a pressure distributor mounted upon a drum rather than upon wheels.

The work done in 1916 has given excellent service. There has been no evidence of foundation troubles which were so prevalent upon the old macadam. The process of surfacing was slow, although no bad results were experienced from this characteristic. The allowing of the seal-coat to penetrate into the void filler is considered to be responsible for the slow surfacing to a smooth typical asphalt surface. It was not until late in the summer of 1918 that this surface developed completely. The surface is still slightly mosaic, but few of the large stones are visible, the mosaic effect being produced by the visible surfaces of ¾ in. and ½ in. stone.

The work undertaken in 1917 was similar in character to the work done in 1916. The only difference worthy of note was the employment upon the section built in that year of crushed diabase obtained locally instead of imported crushed basalt. The results obtained in 1917 compared favorably with the results secured in 1916. The completion of the work carried out in 1917, however, extended late into the fall. Freezing weather was experienced before the work was completed and several light snow storms occurred. Upon the portion done last, light maintenance was required the following spring, but upon the whole this work was less than was anticipated in view of the conditions surrounding the construction.

Bituminous Macadam Wearing Surface

The wearing surface laid upon the section rebuilt in 1918 was bituminous concrete. The rock available in the vicinity of this section was not deemed suitable for use in the wearing surface and imported stone was not considered because of the desire to curtail rail shipments in conformity with recommendations of Federal authorities and also because of the long haul involved from the nearest railroad station. The local rock was employed for the crushed stone base, for which use it was deemed adequate. The mineral aggregate employed for the bituminous concrete surface consisted of local sand and gravel screened and combined to conform in grading of sizes to the "Topeka" specification. There was nothing of special interest in the manner of mixing and laying of the wearing surface.

Our reconstruction is not wholly confined to the types of surfaces employed upon the work here described. The rebuilding of a portion of this line is characteristic, however, of the work which we are doing upon other roads in the nature of the problems to be solved and in the manner of working out the details of the methods to be employed in making the reconstructed roads serviceable at all seasons for all types of vehicles.

Paving and High Prices

Editorial from Urbana, Illinois, Daily Courier, Jan. 14, 1919

The average citizen of Urbana would agree without much argument that it would be a splendid step forward for this community to lay some four or five miles of pavement this year. There are a half dozen streets that ought to be paved which are now unimproved, and there are as many more which have been paved in years gone by, but whose present condition is a reflection on the progressive spirit of the community, as well as a continuing annoyance to those who have to make use of them.

These facts are generally admitted, but when it comes to concrete proposals to remedy the situation, the first barrier raised is that of excessive cost.

Paving does cost more than before the war. It costs a great deal more. Some claim twice as much.

This, in itself, is not as great an objection as some people would have you think. Costs, after all, are relative. When paving prices are low, the prices of other commodities are also low, and those of us who make our living by disposing of the commodities we produce or the services we have for sale, are in no better position, relatively, to buy paving when prices are low than when prices are high.

When prices are high, as at present, money is plentiful, and practically everyone has work at profitable prices. Altho living expenses are high, it is possible to pick and choose what we shall buy, and it is feasible so to conduct our personal affairs as to have a surplus, if we make up our mind to it.

When prices are low, employment is uncertain, irregular, and for some, impossible to obtain. Money circulates less freely and most of us are afraid to spend a nickel for fear we will never get another.

If we wait for prices to go down before we start to pave, we will be in no position to pave when the condition demanded is attained. It is much more of a hardship on a community to thrust an ambitious scheme of public improvement on its property owners in the face of stagnation and panicky conditions, than it is when conditions are what they are today, with money circulating freely, with every one employed, and with no one feeling the pinch of hunger or privation.

The way to maintain good times and flush conditions is to keep business going. We must keep the dollar turning over, and over, and over. We make money, in a business sense, by spending it, not by saving it. Saving has its uses, and its virtues are indisputable, but there is a time to save and a time to spend. Stagnation is not prosperity. It is business death.

We should not be alarmed because our dollar will not buy as much paving as it used to do; neither are we justified in waiting to start such enterprise, for the day when the dollar will buy as much as it did in 1893, or even 1915. Those days may come again—which God forbid—but when they do, we will be far less able as a community to undertake the expense of public improvements than we are today.

We are through with the war; we are entering the channels of peace; the road to prosperity lies invitingly ahead of him who will seize his opportunity in time. Action is demanded. We should not remain asleep at the switch, nor let the rising sun of a renewed prosperity find our train hopelessly blocked on a side track while the rails on the main line rust from disuse.

Urbana's watchword this year should be "Full speed ahead."

Why Returning Yanks Will Boost Good Roads

Maj. D. D. Guilfoil, commanding the First Battalion of the 108th Engineers, in writing from Echternach, Luxembourg, to J. A. Sauerman, of Sauerman Bros., Chicago, tells why the returning American soldiers will be good roads boosters. He writes:

"I sure would have liked to have been in Chicago during that Good Roads Convention. If there is one thing I can talk about now it is good roads. Also, I have quite a flow of language concerning bad roads and no roads at all, having encountered both over here.

"That Illinois bond issue sounds good to me. Really believe that you will find an increase in the demands for more road improvements when the army gets back, for there is not a man over here who has not experienced personally the benefits of good roads and the discomforts of bad ones. What is more, it has been brought home to them in such a way that the war side of it will be entirely removed and they will want the good roads purely from an economic view.

"I have built roads out of every conceivable material. There is one little ruined French village that once had a fine large church. This church, together with all the other buildings, had been more or less shot to pieces. Mostly more. Today you will find the church and several other buildings are the component parts of a very fine road that I built through that section when our troops advanced. Many and many a time have I thanked whoever is to blame for the fact that nearly all the villages are built of stone. When we arrived at that spot the road had entirely disappeared; shell holes and road mines, for 1 kilometer, and the boche had flooded the section with 18 ins. of water. Three hours after we put over the first horse transport, and seven hours after we put over a train of 65 motor trucks. You see, we couldn't wait for material to come up from the rear."

How the City of Quincy, Illinois, Purchased a $1,000,000 Water Works Plant with $380,000

By W. R. Gelston, Superintendent of Water Works, Quincy, Ill.

The first water works plant at Quincy, Illinois, was built and owned by the city. Municipal ownership did not prove satisfactory and in the year 1873, the plant was sold to private parties. The city gave the new owners a 30 year franchise but reserved, to the city, the right to repurchase the plant at the expiration of the 30 years by a clause in the contract reading as follows: "At the expiration of 30 years from date of this ordinance, if no agreement can be made for renewal or continuance of contract, said city shall pay for such works, their then actual cash value."

Much Friction Develops

Much dissatisfaction soon arose concerning water rates and there was a continuous conflict between the owners and the city. In the year 1890 and again in the year 1894, the city council declared that the construction of a municipal water works plant would be the only solution of the existing differences.

In the year 1895, the city council passed an ordinance providing for the establishment of a water works sinking fund and for placing in this fund, at the end of each fiscal year, any funds remaining in the appropriations for the various city departments.

About $12,000 were placed in this sinking fund as soon as the ordinance was adopted. In August, 1903, when the 30 year water works franchise expired, the sinking fund amounted to approximately $250,000.

Appraisal

Just before the expiration of the contract, the city council secured the services of Messrs. John Alvord, Daniel W. Mead and Hiram Phillips for the purpose of making an appraisal of the water works property. These engineers fixed the value of the plant at the date of the expiration of the franchise, at $649,159.

The city did not have sufficient money to buy the plant and it was already in debt beyond the constitutional limit and could not borrow money with which to purchase the works. An attempt was therefore made to arrange a new contract with the owners. The owners refused to accept anything other than

a 20 or 30 years' renewal of the old contract, with no change in rates. Finally they gave the city and its assigns a written option under which the works might be purchased at any time prior to October first, 1904, at the appraised valuation.

New Company Incorporated.

Certain Quincy bankers were then asked to finance a new water works corporation and with their assistance, the Citizens Water Works Company was incorporated. The company was capitalized at $100,000 and the balance of the necessary money was raised by the company by issuing 5 per cent. first mortgage bonds for $300,000 and 6½ per cent second mortgage bonds for $250,000. The city transferred its option to the company and the plant was purchased thereunder.

Although the city did not invest any money in this venture, the contract entered into with the water company gave to the city substantially all of the advantages which would have followed from immediate municipal ownership and eliminated practically all the evils which usually result from such ownership. The Citizens Water Works Company was, to all intents and purposes, merely a holding company which was organized to hold and operate the water plant for the city until the financial condition of the city would permit the purchase of the property.

By the terms of the contract, the city was given the right to purchase the plant, at any time, together with all extensions and improvements made by the company for the sum necessary to enable the company to pay back to its stockholders the $100,000 which they had invested in the enterprise, and to pay the indebtedness of the company then outstanding. Since no increase was ever made in the amount of capital stock, or bonded indebtedness, the city had the right to buy the plant, at any time, at the appraised valuation of $649,159, regardless of any increased value due to extensions or betterments made and paid for out of the earnings of the plant.

Contract Provisions

The contract provided for the payment of 6 per cent. dividends, to the stockholders on the capital stock (and no more), and for the payment of the interest on the bonded indebtedness, from the earnings of the plant. The city guaranteed the payment of the dividends and interest so the stockholders and owners of the bonds had good safe investments. After the payment of the dividends and interest, the city was entitled to receive all of the benefits of the net earnings.

The company was permitted to use the net earnings in making extensions of the distribution system which would, at the outset, reasonably promise a return of 4 per cent. on the investment. With the consent of the city council, extensions could also be made where large feeder mains were needed but where the required annual revenue could not be secured. Extensive changes or improvements in pumping station or purification equipment could only be made with the consent of the city council.

The company was also allowed to lay aside, from the net earnings, an emergency fund of not to exceed $25,000, which had to be kept at interest at current savings bank rates.

The city reserved the right to change the water rates if the plant earned more than seemed to be necessary and the city had the right to order any surplus money to be used in paying off bonds of the company.

The management of the water plant was placed in charge of a Board of Directors, consisting of three members, one appointed by the city council and two elected by the stockholders of the company.

The company was obliged to make an annual financial report of receipts and expenditures to the city council and the city could have an audit of the company books made at any time.

Unique Feature of Contract

The unique feature of this contract with the company was the arrangement by which the city was enabled to increase the interest rate on its water works sinking fund. As previously stated, the water works sinking fund amounted to $250,000, when the water company was organized. The city had no legal power to purchase stock of the company with this fund and it could not invest it in the bonds of the company. The city could only order the city treasurer to deposit the fund in some bank duly incorporated under the laws of the United States or of the State of Illinois. The company, however, agreed to sell the bonds to such banks as might be designated by the city. This enabled the city to go to the banks and propose that it would deposit its $250,000 water works sinking fund with them and thus enable them to purchase the second mortgage bonds of the company, in the sum of $250,000, and that it would designate them as the parties to whom the bonds must be sold, provided the banks would agree to pay 5 per cent. compound interest on the water works sinking fund. Three Quincy banks accepted this proposition and the sinking fund was divided among them. Since the second mortgage bonds were made to draw 6½ per cent. interest, this arrangement allowed to the banks a net profit of about 1 per cent. on the sinking fund after making allowance for the 15 per cent. reserve fund which the banks were required by law to hold in cash in their vaults.

Then the first mortgage bonds, in the sum of $300,000, were made to mature in annual installments, each installment so maturing being made equal, as nearly as practicable, to the amount of the interest which the city would receive, in such year, on its water works sinking fund. Then there was inserted in the second mortgage a provision that there should be issued thereunder, additional bonds aggregating $300,000 (which was the amount of first mortgage bonds issued) and that these additional bonds should bear 6 per cent. interest and should be issued from year to year in sums equal to the maturing first mortgage bonds for such year and should be sold for the purpose of taking up and cancelling such maturing first mortgage bonds. The city deposited in the three banks, each year, the interest it received on its sinking fund and the banks then purchased the new second mortgage bonds.

Financing Plan

Table I shows the plan by which the first mortgage bonds were to be cancelled from year to year and how the amount of second mortgage bonds outstanding increased each year as the water works sinking fund increased. According to this plan, all of the first mortgage bonds would be replaced by second mortgage bonds on Oct. 1, 1920. On that date, the second mortgage bonds would aggregate $550,000 and the water works sinking fund would amount to the same sum and be suf-

TABLE I—PLAN FOR PAYING OFF FIRST MORTGAGE BONDS BY ISSUING NEW SECOND MORTGAGE BONDS IN EQUAL AMOUNTS.

Date	Amount of first mortgage bonds maturing	Interest city will receive on its W. W. Sink. fund	Total amount of second mortgage bonds	Total Amt. of city's water works sinking fund drawing 5% compound interest
October 1, 1904.....	.....	.....	$250,000	$250,000
October 1, 1905.....	$ 12,500	$ 12,500	262,500	262,500
October 1, 1906.....	13,000	13,125	275,500	275,500
October 1, 1907.....	14,000	13,775	289,500	289,500
October 1, 1908.....	14,500	14,475	304,000	304,000
October 1, 1909.....	15,500	15,200	319,500	319,500
October 1, 1910.....	16,000	15,975	335,500	335,500
October 1, 1911.....	17,000	16,775	352,500	352,500
October 1, 1912.....	17,500	17,625	370,000	370,000
October 1, 1913.....	18,500	18,500	388,500	388,500
October 1, 1914.....	19,500	19,425	408,000	408,000
October 1, 1915.....	20,500	20,400	428,500	428,500
October 1, 1916.....	21,500	21,425	450,000	450,000
October 1, 1917.....	22,500	22,500	472,500	472,500
October 1, 1918.....	23,500	23,625	496,000	496,000
October 1, 1919.....	25,000	24,800	521,000	521,000
October 1, 1920.....	29,000	26,050	550,000	550,000
Totals.....	$300,000	$296,175		

ficient to pay off all of the bonded indebtedness on the plant, leaving only the capital stock of the company to be purchased, in order to assume complete ownership of the plant.

The Citizens Water Works Company took possession of the property on October first, 1904 and first mortgage bonds were paid off and cancelled and new second mortgage bonds were issued and sold to replace the maturing first mortgage bonds just as planned and indicated on this tabulation until Oct. 1, 1916.

In the meantime the city had paid off most of its indebtedness and could assume new obligations of sufficient size to provide the balance needed for the purchase of the property. As soon as this condition existed, the purchase of the water works became a political issue. The proposal to purchase the plant was finally submitted to the voters at the regular city election in April, 1916, and carried by a large majority. The transfer to the city was made on Oct. 1, 1916.

The city paid for the plant, as provided by the contract, the sum of $649.158 which was the appraised valuation on Oct. 1, 1904, and in addition thereto, the premium which was required to be paid on all unmatured first mortgage bonds, amounting to $1,137.35, making a total of $650,296.35.

In making this payment, the city used all of its water works sinking fund, a new water works bond issue of $130,000 and made up the balance from the earnings of the plant which were required by the contract to be turned over to the city with the plant.

The new bond issue of $130,000 is being paid off from the earnings of the plant at the rate of $26,000 per year and on July 1, 1921, they will all be cancelled and the city will own its water works plant free of all incumbrances.

During the twelve years the plant was operated by the Citizens Water Works Company, no changes were made in water rates. The first year the company controlled the plant, the gross earnings were $93,157 and they increased to a maximum of $133,000 per year.

Extent of Works

On Oct. 1, 1904, there were 46 miles of mains, 314 fire hydrants, 3933 services and 1996 meters in use. When the city purchased the plant, on Oct. 1, 1916, there were 75 miles of mains, 432 fire hydrants, 6540 services and 4516 meters in use. All of these additions were paid for from the earnings of the plant.

The Citizens Water Works Company also, with the consent of the city council, scrapped the old pumping station and filter plant and built and equipped a new pumping station and a modern concrete filter plant, including sedimentation basins. A new 36 in. cast iron intake pipe, 1,850 ft. long was laid in the Mississippi River. These improvements were also paid for from the earnings and cost approximately $200,000.

After the city purchased the property, Messrs. Alvord and Burdick made a new appraisement of the plant. They fixed the value of the property, on Oct. 1, 1916, at $1,070,000. The city paid $650,296.35 for it.

Mr. Theodore B. Pape, who was Corporation Counsel for the city in the years 1903 and 1904 worked out the details of the contract with the Citizens Water Works Company, and served as a member of the Board of Directors of the Company throughout its existence and to him should be given the credit for any merit which may be found in this unique method of attaining municipal ownership.

Some Features of Highway Work in Kansas

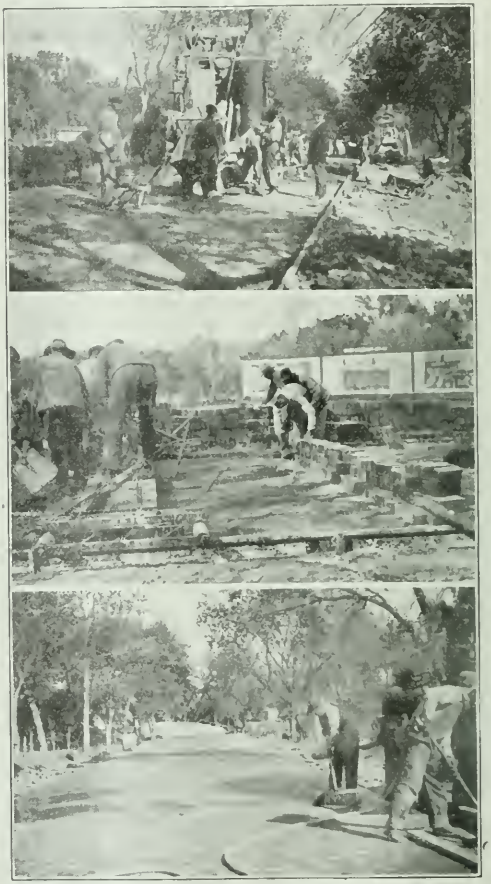
By M. W. Watson, Acting State Highway Engineer, Kansas Highway Commission, Topeka, Kans.

The 1917 legislature of Kansas created a State Highway Commission composed of the Governor, as ex-officio chairman, and two commissioners, one to reside east of the 6th Principal Meridian and one west of it.

Shortly after the passage of this act, the Commission met and appointed a State Highway Engineer, a Secretary for the Commission and various other employees. The present organization places the supervision of the road and bridge work in complete charge of the State Highway Engineer, who is assisted in their respective fields by the road engineer and the bridge engineer.

County Engineers

Each county is required to have a county engineer, whose appointment is subject to approval by the State Highway Commission and who serves for a term of two years. The engineer



VIEWS ON FEDERAL AID PROJECT NO. 12 IN GEARY COUNTY, KANSAS.

Mixing and Placing Concrete for Base of Brick Pavement—Laying Monolithic Brick Pavement, Showing the Parish Template in Operation—Grouting the Brick.

in addition to being an employee of the county, is in many respects a representative of the State Highway Commission in that county.

The Commission prepares standard plans and specifications for all road and bridge work. The plans for each individual bridge on a county road and each bridge the estimated cost of which is $2,000 or over on a township road, when constructed by the county, must be approved by the State Highway Engineer.

All Federal aid road work is under the direct supervision of the State Highway Engineer.

The Constitution of Kansas prohibits the state from engaging in any internal improvement and the Supreme Court has interpreted this clause as applying to road work, which makes it impossible for the state to have a fund for the construction of roads. The Federal aid fund is, therefore, furnished by the counties to be expended under state supervision.

Benefit Districts

The Kansas law provides that when any number of persons living in the vicinity of a road may so desire, they can form what is called a "benefit district" and petition the board of county commissioners to improve any laid out public road. The petition must contain the signatures of 51% of the resident land owners owning at least 35% of the land within the district or 35% of the resident land owners owing 51% of the land within the district, or the owners of 60% of the land within the district. By "resident land owners" the law specifies that they must live in the county and own land in the benefit district. When the last of the three alternatives applies, the signature of any land owner, regardless of where he resides, becomes effective on the petition. The petition is than presented to the board of county commissioners and if they deem the road of public utility, they declare it so by an order of the board and direct the county engineer, or some other competent highway engineer to prepare the plans for its improvement.

The petition must specify the definite location of the road by the place of beginning, the place of ending and other fixed locations, also the type and width of roadway desired, which may be different for different sections of road, and the number of annual assessments to be levied upon the land in the district, with the definite outlines of the boundaries and the land included in the district. The annual assessments can extend for not less than 10 years nor more than 20 years.

Any property owner in the district may pay his portion of the assessment in cash or can allow it to be paid annually for the period of the assessments. The board has a right to issue bonds covering the outstanding indebtedness on the work. After the work is completed and all Federal aid or donations have been deducted, the county pays 50% of the cost, the township 25% and the land within the district 25%, according to the benefit accruing to each piece of land.

Federal Aid Roads

The State Highway Commission has decided to give 15% Federal aid on any piece of construction which is located on the designated connecting system of Federal aid roads. This system of roads comprises about 3,500 miles and connects the principal cities throughout the state and covers the main through traveled highways. The Commission does not allow Federal aid on disconnected sections of roads.

Shortly after the formation of the Commission, war was declared and the difficulty in obtaining materials and labor has greatly retarded the progress of any hard surfaced road construction in the state. However, the Commission has been continuing to receive and approve petitions for road construction with the idea in view of getting ready for work after the war.

Federal Aid Allottments

Kansas has been allotted by the Government the following sums:

For the year ending June 30, 1917.....	$143,207.40,	available June 30, 1920
For the year ending June 30, 1918.....	286,414.80,	available June 30, 1920
For the year ending June 30, 1919.....	429,622.20,	available June 30, 1921
For the year ending June 30, 1920.....	572,829.60,	available June 30, 1922
For the year ending June 30, 1921.....	716,037.00,	available June 30, 1923
Total amount available.....	$2,148,111.00,	during 5 year period.

Applications for Federal aid have been made to the Commission for 28 sections of road, all of which have received the Commission's approval. 19 sections have been submitted to the Office of Public Roads, of which 15 sections have been approved, 2 rejected and 2 have not yet been considered by the Government.

List of Approved Federal Aid Projects

The following is a list of Federal aid projects which have been received and approved by the State Highway Commission, with the width and length of each:

County	Name of Road	Proj. No.	Type	Width Feet	Length Miles
Barton,	Santa Fe Trail	3	Brick	20	27.50
Bourbon,	Ft. Scott-Pittsburg	6	W. B. Macadam	14	6.39
Bourbon,	Jefferson Hwy., North	5	W. B. Macadam	14	8.70
Bourbon,	Jefferson Hwy., South	9	W. B. Macadam	14	11.71
Bourbon,	Ft. Scott-Wichita	8	W. B. Macadam	14	8.00
Cloud,	Clasco Simpson		Concrete	16	8.25
Douglas,	Fort to Fort Hwy.	7	Concrete	18	18.34
Finney,	Santa Fe Trail		Brick	20	28.00
Ford,	Santa Fe Trail	14	Brick	20	11.00
Geary,	Golden Belt, W. of Junction City	10	Concrete	18	7.55
Labette,	32d St., Ozark Trail, King of Trails	2	Gravel	16	44.50
L'venworth,	Fort to Fort Hwy.	13	Concrete	18	22.00
Mitchell,	Beloit-Asherville	1	Concrete	16	11.25
Reno,	New Santa Fe Trail	15	Brick	18	17.7
Sedgwick,	Central Avenue	11	Concrete	18	7.375
Shawnee,	Lawrence & Topeka State Road	4	Concrete	18	10.00
Rice,	New Santa Fe Trail		Brk. or Conc.	18	2.31
Geary,	Golden Belt east of Junction City	12	Brick	20	1.12
Rice,	New Santa Fe Trail	16	Brk. or Conc.	18	3.00
Rice,	Old Santa Fe Trail		Brk. or Conc.	18	5.00
Sedgwick,	Lawrence Ave., Meridian Trail		Brick	20	12.50
Allen,	State Street Road	19	Grav. or W. B. Mac. & Resurf.	16	4.25
Allen,	Iola-Moran Road	18	Concrete	18	1.00
Douglas,	Old Santa Fe Trail		Concrete	16	23.25
Geary,	Golden Belt Road	17	Brick	20	0.90
Reno,	S. Fe Tr. Cut Off & Santa Fe Tr. No. 2 Road		Brick	18	35.00
Johnson,	Santa Fe Trail		Recon. Bit. Mac.	18	6.00
Allen,	Humboldt-Chanute Road		W. B. Mac. or Grav. & Conc.	20	3.25

Rejected by Federal Government.

The total estimated cost of this work is approximately $8,076,760.12.

The Federal aid which will be received according to allotment is approximately $1,219,975.23.

Project No. 12 in Geary County

Project No. 12 in Geary County has been awarded at a contract price of $41,182.80 to M. R. Amerman, of Salina, Kansas. The earth work contract on this section, which is not a part of the project, was awarded for $2,870.32. The culvert work contract was awarded for $1,020. No Federal aid was received on earth work or culverts.

This road is of considerable military importance, connecting the city of Junction City with the military cantonment at Fort Riley and Camp Funston, Kansas.

From a traffic census taken by Government engineers, it is estimated that there will be about 8,000 vehicles per day on the road after completion.

Monolithic Brick Chosen

The contract was awarded on July 24, 1918, and the work started during the week of August 5, 1918. The work was advertised to receive bids on two different plans. One was for a concrete pavement throughout, the other for a monolithic brick road from Station 0+10.8 to Station 57 and a reinforced concrete road from State 57 to Station 59+14. The latter plan was selected by the board after the bids were read.

The monolithic brick road is composed of a wearing surface of 3 in. vertical fiber brick with cement grout filler and has a base 3 ins. thick on the sides and 4½ ins. thick in the center, using a 1:3:5 mixture of concrete. The reinforced concrete section is of the two course type and reinforced with 45 lbs. of mesh reinforcement to each 100 sq. ft. of pavement.

Much Road Work Coming

Before many months at the present rate of progress, there will be filed with the State Highway Commission applications

for road work to the value of about $14,000,000, and although ranking as one of the last in the matter of hard surfaced roads constructed, Kansas will soon rank well up among the first. There are about 111,000 miles of public highways in Kansas, of which only about 1.3% have been improved by any type of surfacing and of this amount about 0.7% is of sand-clay.

The Honorable Arthur Capper, Governor, is chairman ex-officio of the State Highway Commission and Mr. R. S. Tiernan, of Fort Scott, and Mr. E. R. Moses, of Great Bend, are the members.

Design and Performance of the Iron Removal Plant for Laundry Water at State School, Sparta, Wis.

By W. G. Kirchoffer, Sanitary and Hydraulic Engineer, 22 N. Carroll St., Madison, Wis.

The State School for Dependent Children, located at Sparta, Wisconsin, has three sources of water supply: the city water for general purposes, that from flowing deep wells for drinking fountains, and that from shallow driven wells, which, until recently, has been used for laundry purposes.

Iron and Manganese

All of these waters carry considerable quantities of iron in solution and the city water has at times a slight amount of manganese. The deep well water is the most highly charged of them all.

The following determinations in parts per million, on these waters were made in the State Laboratory of Hygiene.

	City Water	*Deep Wells*	*Driven Wells*
Total Solids	108.0		
Chlorine	3.00		
Hardness		97	60
Alkalinity	80.0	75	25
Iron (average)	2.58	3.19	
Manganese	0.1	0	

Geological Conditions

Sparta lies in the valley of the La Crosse river which is carved deep in the Potsdam sandstone. The surface material about Sparta is largely sand derived from the disintegration of this rock. The surface of the rock formation is reached at varying depths but in the vicinity of the city water works and state school it is at about 100 feet. Ground water is found in the sand formation at a depth of from 10 to 20 feet, depending on the elevation of the ground above the bottom of the valley. At depths of 187 feet and 297 feet, underneath hard flinty layers of rock, are found sources of water that will flow at the surface.

There are many of these flowing wells about Sparta, but all are highly charged with hydrogen sulphide and iron. The city supply was formerly from the shallow ground water supply, but is now a mixture from a deep well and the old ground water supply. The water for the drinking fountains at the state school is also from one of these deep wells.

Some years ago in an effort to get a supply for laundry use that would be reasonably free from iron the shallow driven wells were put down. These have never been entirely satisfactory as the water contains some iron and the points clog up and have to be replaced frequently. It was suggested by a former superintendent of the school, that a supply of rainwater might be obtained from the roofs of the various buildings of the school by collecting it in cisterns. A detailed investigation of this scheme revealed the fact that it would require the rains of five months to produce enough to last the laundry only two weeks.

Experimental Plant.

At about this time the writer was investigating methods of removing the iron from available sources of water supply for the city. A joint investigation of the deep well water at the state school was made for the city and school. A small experimental plant consisting of three ordinary oil barrels was used for this purpose. The first two were filled with new coke broken up to about a 2 in. size and in the third barrel a sand filter was constructed. All of the sand and gravel was thoroughly washed for the purpose of removing all foreign matter and extremely fine sand such as would pass sieves 80 to 100 to the inch.

The well water was discharged onto the coke in the first barrel through a circular lawn sprinkling nozzle, then it passed down through the coke to a connection between the first and second barrels and then upward through the second barrel to the outlet connected to the third barrel in which the sand filter was placed. The outlet of the sand filter was at the bottom and was controlled by a valve. The rate of flow was about three-quarters of a gallon per minute. Samples of the raw water and effluents from the coke and sand filters were

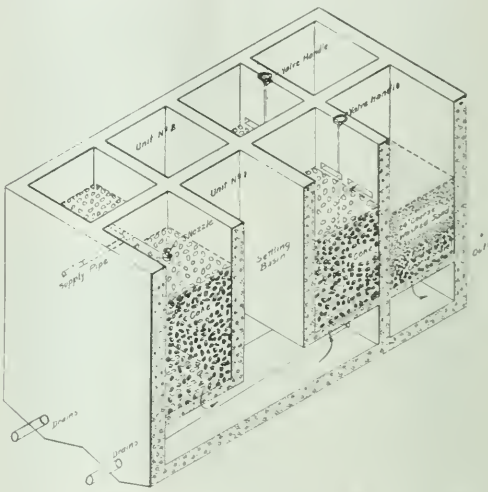


FIG. 1—ISOMETRIC VIEW OF IRON REMOVAL PLANT, STATE SCHOOL, SPARTA, WIS.

taken at frequent intervals. These were sent to the hygienic laboratory and analyzed for iron and manganese. No manganese was found.

Results of Analyses Satisfactory

The results of these analyses are given in Table I and are shown graphically on Diagram 1. These results were so highly satisfactory that a report was made to the State Board of Control, the executive body in charge of the school, recommending the construction of a plant to treat 6,000 gallons of water per day. This plant was designed in the summer of 1918 and has just recently been put into operation. The treated water is stored in a concrete reservoir, 16 ft. in diameter by 10 ft. deep. The plant was designed to operate in exactly the same manner as the test plant was operated, except that it was built in duplicate and a settling tank was placed between the first and second coke contact filters. The settling chamber extended under the coke filter and was provided with a "V"-shaped bottom so as to draw off the deposit into the sewer when necessary. Valves were also provided to drain the water off from above and below the sand filters and for back washing them when necessary. The nozzles used were of the round Taylor type such as are used for sewage on sprinkling filters. The water from the flowing well has pressure enough to throw the water in a thin sheet but not into a spray.

Fig. 1 is an isometric view of the plant with the side wall removed, and Fig. 2 is a plan showing the location of the plant and connections to the well and reservoir. From the reservoir the treated water is raised by steam pumps to an elevated wood tank as it is needed.

The Sand Used

The sand used in the filters was analyzed by a nest of standard sieves with the following results:

Held on 4	1.15	per cent.
Held on 10	38.0	per cent.
Held on 20	26.9	per cent.
Held on 30	15.1	per cent.
Held on 40	12.0	per cent.
Held on 60	7.2	per cent.
Held on 80	.3	per cent.
Held on 100	.1	per cent.
Pass 100	.06	per cent.

Cost of Labor

This plant was built by day labor under the direction of Mr. C. H. Phillips, superintendent of construction for the Board of Control. The cost of the plant, including a frame building covering it, was as follows:

Superintendent of Construction	$293.55
Foreman	83.33
Rock	7.10
Sand	58.17
Freight and express	11.95
Labor	295.42
Hauling stone and sand	73.33
Cement	190.50
Lumber	168.17
Stone	110.00
Labor	12.00
Miscellaneous materials	159.54
Two manhole covers	11.00
	$1,472.06

Operating Results

After the plant had been in operation about two months, determinations of iron and hardness were made by the Hygenic Laboratory with the following results in parts per million:

	Effluent from Coke filter	Effluent from Sand filter
Iron	0.6	0
Total hardness	101.5	84.3

Not only was the iron completely removed by this treatment, but the hardness was reduced about 16%. This water is slightly harder than that from the driven wells, but if this hardness proves objectionable, the sand filters are built so that a layer of zeolite can be placed beneath the sand and thus produce a water of zero hardness.

Extracts From Specifications

Construction—The reservoir is to be constructed of reinforced concrete, including side walls, bottom and cover. The side walls are to be 12 ins. thick and are to be reinforced with ½ in. horizontal circular rods 2 ins. from outside face and with 18 vertical rods spaced 4 ft. 6 ins. c.c. The bottom of the reservoir will be 9 ins. or more thick, depending upon the level

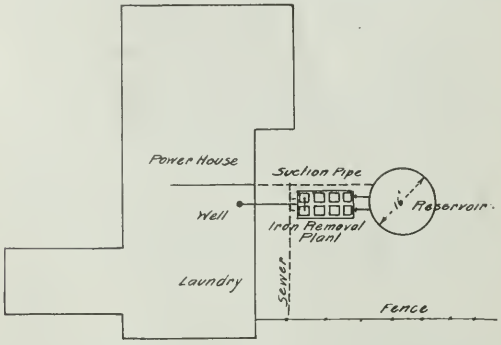


FIG. 2—PLAN OF LOCATION OF PLANT AND CONNECTIONS TO WELL AND RESERVOIR.

of the materials when the excavation is completed. The bottom of the reservoir will be reinforced with ½ in. rods, radial and circular rods, and placed 2 ins. from the surfaces of the concrete.

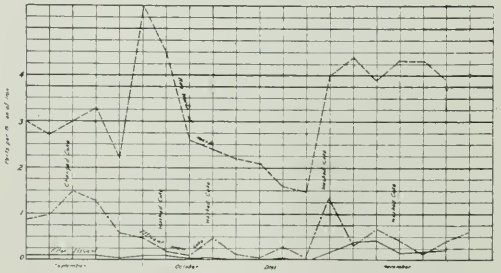


DIAGRAM 1, SHOWING RESULTS OF OPERATION OF EXPERIMENTAL IRON REMOVAL PLANT.

The iron removal plant walls and bottom will be constructed of reinforced concrete 6 ins. thick, except the filter bottoms, which will be 3 ins. thick.

Size and Shape—The reservoir is to be circular in form, 24 ft. inside diameter and side walls 10 ft. high above the bottom of the reservoir next to the walls. The side walls on both sides are to be vertical. The bottom of the reservoir will have a

TABLE I—SHOWING THE REMOVAL OF IRON FROM DEEP WELL WATER AT THE STATE SCHOOL, SPARTA, WIS., BY AERATION, COKE AND TREATED SAND FILTER.

Raw Water Sample No.	Kind of Filter	Iron in Raw Water	Effluent from coke filter	Amount removed by coke	% Removed by coke	Amt. in filtrate	Amount removed by sand	% Removed by sand
7	Aeration, coke and sand filters, 6 lbs. per min.	3.0	1.5	1.5	50	0.1	1.4	93
10	Aeration, coke and sand filters, 6 lbs. per min.	3.3	1.3	2.0	60	0.1	1.2	92
13	Aeration, coke and sand filters, 6 lbs. per min.	2.2	0.6	1.6	73	0.05	0.55	91½
16	Aeration, coke and sand filters, 6 lbs. per min.	5.5	0.5	5.0	91	0.1	0.4	80
19	Aeration, coke and sand filters, 6 lbs. per min.	4.5	0.2	4.3	95½	0.1	0.1	50
22	Aeration, coke and sand filters, 6 lbs. per min.	2.6	0.1	2.5	96	0.05	0.05	50
25	Aeration, coke and sand filters, 6 lbs. per min.	2.4	0.5*	1.9	79	0.05	0.45	90
28	Aeration, coke and sand filters, 6 lbs. per min.	2.2	0.15	2.06	93	0.0	0.15	100
31	Aeration, coke and sand filters, 6 lbs. per min.	2.1	0.05	2.05	97½	0.0	0.05	100
34	Aeration, coke and sand filters, 6 lbs. per min.	1.6	0.3*	1.3	81	0.05	0.25	83½
37	Aeration, coke and sand filters, 6 lbs. per min.	1.5	0.05	1.45	96½	loat	...	.....
40	Aeration, coke and sand filters, 6 lbs. per min.	lost	1.36*	....	....	0.16	1.20	88
43	Aeration, coke and sand filters, 6 lbs. per min.	4.4	0.32	4.08	92½	0.4	...	.....
50	Aeration, coke and sand filters, 6 lbs. per min.	3.88	0.68	3.20	82½	0.44	0.24	35
53	Aeration, coke and sand filters, 6 lbs. per min.	4.32	0.44	3.88	90	0.16	0.28	64
56	Aeration, coke and sand filters, 6 lbs. per min.	4.32	0.12	4.20	97	0.2	...	.....
59	Aeration, coke and sand filters, 6 lbs. per min.	3.88	0.44	3.41	89	0.24	0.20	45½

*Back washed coke previous to this sample.

slope of 6 ins. towards the outer edge of the sump. The sump will be a depression in the bottom of the reservoir 3 ft. square and 1 ft. 6 ins. deep.

The iron removal plant will be rectangular in plan 7 ft. 6 ins. wide, outside, by 14 ft. 6 ins. long and will consist of concrete tanks 3 ft. square in which will be located the coke and sand filters.

Coke—The coke to be used in this plant should be clean foundry coke of medium size and in sufficient quantity to fill the coke filters to the levels given.

Sand and Gravel For Filters—The sand used for the filters should be a coarse clean sand of uniform size of sand grains. Before placing in the filters the sand should be screened through a ¼ in. mesh (3/16 mesh is better if obtainable) and then thoroughly washed on the surface of a sloping platform so as to remove all dirt, silt and fine sand grains. A quantity of sand 20% in excess of that at first required should be prepared so as to have some to replace that which is lost in scraping. The gravel should be assorted for two sizes, ¾ in. to 1½ in. and ¼ in. up to ¾ in. This should also be washed to remove silt, clay and sand.

Filter Bottoms—The bottoms of both the coke and sand filters should be made of reinforced concrete with tapering holes through them, these holes are to be made by placing blocks cut from 2x4 in. pieces on the surface of the forms at the proper locations. The forms for the sand filters must be cast separately and then placed after the forms are removed from the filter compartment. These should be cast ¼ in. smaller all around than the inside dimensions of the filter so that they can be placed readily. The bottoms for the coke filters should be poured at the same time as the side walls are poured and the reinforcing steel must be banded with that in the side walls. The pipes in which the valve rods are placed must be set before pouring the concrete.

Drain to Filters—The central and lower compartments of the plant will be connected with the sewer at two points. These drains will be controlled by shear gates located inside the plant and set in the north wall. The handles for these valves will have to be hinged so as to allow the handle to operate in a 1 in. pipe. The shear gates are of the McDonald Foundry Co., Columbus, O., type.

Drains to Sand Filter—For the purpose of draining each sand filter and to provide water for back washing them, there will be placed in the walls between the coke filters and the sand filters a pipe and valve operated by long handle extending to top of filters. The pipe and valve should be 2 in., 2½ in. or 3 in. in diameter.

Wash Water Overflow—Each sand filter will be provided with a valve located near the top of sand to be used when back washing the sand filters. These should be 2, 2½ or 3 in. in diameter as may be desired.

Connections to Reservoir—Each filter will be connected to the reservoir with wrought iron pipe and valve of same size. The valve may be any type of valve or shut off, so made that it can be operated by a key from the top of the ground. The valve should be protected by pieces of 6-ft. vitrified pipe extending to surface.

Description of Plant—This plant is for the removal of iron from the deep well water which is to be used for laundry purposes. The process consists of spraying the water over coke, by means of a specially designed nozzle, in a thin film, thus aerating the water. It then flows downward through the first compartment of coke into a small settling reservoir, then upward through a second contact of coke to the sand filter, when it flows downward to the storage reservoir. The plant will be constructed in duplicate. The plan of operation will be to use one unit until the sand or coke or both becomes so clogged with iron that it will not pass 4 gals. per minute. Then the other unit will be put in use and the first one will be drained out to the sewer and the coke washed, if necessary, with a hose, and the sand filter back washed with water from the settling reservoir (between the coke filters). The least washing that can be done and still supply the necessary amount of water, the better will be the results. The exact amount of washing can best be told by experience.

Recommended Procedure in Cleaning Streets in Rochester, N. Y.

By James W. Routh, Chief Engineer and John T. Child, Assistant Engineer, Rochester Bureau of Municipal Research, Inc.

The present article comprises a brief, constructive criticism of the common methods of street cleaning with special reference to conditions in Rochester, N. Y. What follows is from the summary of a report on the problem of street cleaning in the city of Rochester, submitted to the mayor and the commissioner of public works by the Rochester Bureau of Municipal Research, Inc. The report, which contains a large amount of data and discussion on street cleaning has just been released.

Nature and Sources of Street Dirt

Street refuse appears in two forms, as fragments of various sizes and as fine dust. It has been traced to a number of different sources, some of which are controllable while others are not. Among the sources of street dirt which can be regulated is the character of street pavements. Poor pavements are the source of much street dirt. For example, in Rochester it costs 53 per cent. more to clean Medina stone block pavements as constructed than it costs to clean asphalt pavements. Street cars are a source of much dirt, and the tracks interfere with effective cleaning, as well as being in themselves sources of dirt. Steps should be taken to require the street railway company properly to construct and maintain its tracks and track areas, so as to reduce as much as possible the amount of dirt from this source.

Other sources of street dirt which can be controlled to a great extent are the throwing of rubbish and litter in streets by the public, the deposition of soot and cinders from the careless burning of soft coal, and the placing of lawn rakings, bush clippings, etc., in the gutters of residential streets These things are largely a matter of public co-operation, and steps should be taken to obtain this co-operation, even to the extent of making the ordinances governing such actions penal ordinances, and insisting upon the co-operation of the police.

Sweeping Streets by Hand

Sweeping streets by hand with push brooms is the oldest and most generally used method of street cleaning. The work is done mostly by patrol sweepers working singly. In Rochester this work is poorly and irregularly laid out and controlled. There appear to be no standards of cleanliness observed, and there are no standard work methods in use. The patrol sweepers' routes should be laid out scientifically and fairly in all sections of the city. Among the various factors influencing the size of these routes are the quantity of dirt deposited, the amount and character of traffic, and the kind and condition of pavements. These, as well as various other factors, should be taken into account in laying out this work.

The equipment used by patrol sweepers is, for the most part, satisfactory, although certain changes in sizes and types should prove of benefit. When standard work methods are established, a standardization of equipment also should be made. Apparently there is no uniform procedure in street sweeping observed in Rochester. Experiments conducted in some of the larger cities indicate general principles to be observed for this kind of work, and these principles should be observed in Rochester.

Street Flushing

Water is the best means of removing from street pavements fine dirt and dust particles which cannot be removed by other means. It is necessary, however, to differentiate between

street sprinkling and flushing. Street sprinkling results merely in the temporary laying of the dust, whereas flushing, if properly done, washes dust and dirt from the pavement. Flushing is done by means of hose, motor flushers and horse-drawn flushers. Motor or machine flushing is perhaps the most satisfactory method of street cleaning. Two motor flushers are operated in Rochester, and analyses of the work done by them show fairly satisfactory results obtained. Certain improvements are possible, however, and performance tests conducted last summer indicate means for adjusting the equipment to obtain better results and to decrease the cost of the work. It is believed that one of the flushers might more economically be transformed into a motor truck for carting purposes, and that three or four additional flushers of high power and modified design should be purchased.

Performance tests and observance of practice last season, together with results of experiments conducted elsewhere, form the basis for suggested motor flushing procedure. Diagrams have been prepared to indicate advisable combinations of nozzles and flushing procedure according to different conditions to be met. These diagrams and this procedure are based on a working pressure of 40 pounds, which was not always obtained last year, owing to the fact that one of the flushers has not a sufficiently powerful engine for the work.

In addition to the suggested modification or standardization of procedure, it is evident that this work should be done under adequate supervision, which is not the case at present. Some of it can be done during the day on residential streets, but no the heavy traffic business streets flushing can be done only at night. This means that a night superintendent of street cleaning is necessary. Even with the best of equipment and most careful supervision, however, it is believed impossible to obtain desired results from motor flushing certain Medina block car track streets. Streets of this kind should be hose flushed until they are resurfaced with asphalt, as many of them should be.

Most of the wagon flushing done in Rochester is done with ordinary sprinkling wagons which cannot do satisfactory work. The city owns some pressure wagons, and when properly operated, fairly satisfactory results are obtained with this equipment. There is great irregularity in local practice of wagon flushing, however, due to lack of proper supervision and the fact that part of it is done by contract, with only superficial inspection. The use of sprinkling wagons for flushing should be discontinued, and in their place more pressure wagons, or, preferably, more motor equipment should be used.

For washing extremely dirty or rough pavements, hose flushing is the most satisfactory method. With hose the stream can be concentrated where needed, and the quantity of water used can be regulated by varying the sizes of the nozzles used. Local hose flushing practice is decidedly irregular and unsatisfactory. Comparatively poor results are obtained at unnecessarily high costs. This is due to a lack of knowledge of the proper method of doing this work and a lack of any standard practice and adequate supervision. The equipment used is not altogether satisfactory, and steps should be taken to make it conform to acknowledged standards when standard work methods are adopted for use.

Street Sprinkling

The sprinkling of hard surfaced pavements is believed to be an absolute waste of water, unless it is done in conjunction with some cleaning operation, such as flushing, machine sweeping, or squeegeeing. Earth and macadam streets, however, require sprinkling to lay the dust, and consequently a certain amount of sprinkling probably will have to be done for some time to come. It is believed, however, that contract sprinkling results in a net loss to the city and in an unusually high profit statistics prove that during the sprinkling season about 40 to the contractors, because of the lax control exercised over the work and because of the large number of rainy days in Rochester during which sprinkling is unnecessary. Weather per cent. of the days have precipitation, which tends to reduce the amount of sprinkling necessary. The payment to the contractor, however, is not adjusted in accordance with the amount of work actually done. It is believed, therefore, that the sprinkling work should be done by the Department of Public Works. (Motor flushers could be used during the day for sprinkling. This would make more economical the operation of this expensive equipment).

Another reason for requiring the work to be done by the Department is that in this way sprinkling work can be coordinated with cleaning work, particularly with flushing and machine sweeping, in both of which sprinkling in advance of the cleaning process generally is of value. Not only should the sprinkling work be taken over by the Department, however, but a large portion of it should be dispensed with in favor of flushing.

Machine Sweeping

Machine sweeping is done by large rotating brooms mounted on wagon frames and drawn by horses. This work is not satisfactorily done in Rochester. The equipment is mostly obsolete and no longer effective; the work is not planned in conjunction with other cleaning processes nor with sprinkling, and supervision over it is lax. The most apparent need for improved machine sweeping work is a fixed standard of practice, which would insure the greatest amount of work being done for the least expenditure of money. The cost during 1917 was unnecessarily high and not consistent in all parts of the city. In future machine sweeping work, standard practice is suggested for use. This entails more extensive use of equipment and better control over the work. It is believed also that the work should be extended to include the sweeping of certain of the heavy traffic and dirty streets in the business section of the city at night.

Special Street Cleaning Problems

The problem of litter is one of the most interesting parts of the street cleaning problem. Litter is the most evident reason for dirty looking streets, and its removal is the source of much work and expense. It is believed that more rubbish cans should be supplied for use of the public, particularly in the business part of the city, and that better co-operation should obtain between the public and the Department in reducing the amount of litter deposited on the street. In addition to this, the litter patrol downtown should be extended as needed and the equipment used should be changed somewhat. The use of a burlap bag, with a spreader to keep the top open, and a stick with a steel point or hook for picking up paper will be found to reduce the fatigue of the laborers.

In addition to improving the quality of work done in picking up street litter, and in connection with it, it is believed that downtown sidewalks should be swept by the street cleaning force. This has been done in certain cities with marked success, and eliminates many of the difficulties which now exist in having the walks swept at the proper time so as to allow the sweepings to be collected together with the street dirt.

The leaf problem is an important one in Rochester, and it is believed that the use of machine sweepers and the enforcement of the ordinances, with some changes in them which would require property owners to gather up the leaves and to place them in burlap bags or barrels for collection, would help to reduce the work involved.

Method Employed in Resurfacing Old Macadam Streets in Madison, Wis.

By George Sullivan, Superintendent of Streets, Madison, Wis.

To resurface an old macadam street the entire surface should be scarified to a depth of about 3 ins. When this is done grade it with the street grader until it is perfectly level.

This result may be facilitated by using a few yards of crushed stone for filling. Then roll it down with the steam roller until it becomes firm or solid. In some cases it may be necessary to use a little screenings and some water in order to get the proper consistency. By all means give it a good thorough rolling. Then apply a good coat of hot tar with the distributor, and cover the tarviated surface with coarse sand or screenings, after which it should be given a thorough rolling. Put enough sand on the tar so that it will not stick to the roller, and after the street is rolled, it will be ready for travel, says Mr. Sullivan, writing in the January issue of The Municipality.

Good Results Secured

We, in the city of Madison, have had the best of results in treating old macadam roads in this manner. Some of the streets we have already repaired in this manner are from 15 to 25 years old, and when resurfaced in this way, are practically as good, and in some cases, better than they were when they were new.

In this kind of work, the city of Madison uses what is known as Tarvia A. We have found this Tarvia A very satisfactory as it seems to set up very quickly and permits travel immediately after it is applied. This Tarvia should always be put on hot.

Repairing Holes

For repairing holes in old macadam pavements we use Tarvia X. For this class of repair work we take an ordinary dump wagon with a division in the middle of the box. We fill one part of the box with crushed stone and the other part with screenings. We take a small iron kettle which holds about two barrels of Tarvia X, with a fireplace in it for heating the material. This kettle is fastened behind our repair wagon loaded with stone and screenings, and the outfit taken to the street to be repaired. With a pick we form a shoulder around the hole in the street to be repaired, and fill the hole up well flush with the pavement. Then with a tamping bar we tamp the stone down until it becomes even and solid and pour in enough of the hot Tarvia X to bind it together. This is then covered with coarse sand or screenings and then tamped down firmly. After this process the street is ready for travel. Patches put on in this manner very seldom give out.

Applying the Tarvia

In surfacing any kind of a macadam street with Tarvia A, the Tarvia should be applied hot, covered with sand or screenings immediately and rolled while the Tarvia A is soft and still hot, as in this way, the tar takes up most of the sand and forms a wearing surface of itself, and naturally proves a great saving to the macadam. It also helps to make rough and uneven pavements a great deal smoother and pleasanter to drive on.

One of the principal factors to be considered in tarviating any kind of a pavement is to have the pavement thoroughly clean and free from all dust, as the Tarvia will not adhere to dust.

We bought our Tarvia A at 8½ cts. per gallon, and our Tarvia X, at 11 cts. per gallon, which is a great deal cheaper than it can be purchased at the present time. We made our contracts last fall and in this way got last year's prices. Sand in Madison this year is very costly. It sells at $1.15 per ton at the bin, which makes it very expensive for covering. It takes on an average of about 428 gals. of Tarvia A to the block, and about 16 2/3 yds. of sand. The average block in Madison consists of about 1,760 sq. yds., which means about 1/3 gal. to the square yard.

Precautions to Observe in Locating New Roads

The following precautions to be observed in locating new roads are suggested by A. Dennis Williams, Engineer-Chairman of the West Virginia State Road Commission:

1. Ground which has a tendency to slip should be avoided if possible.

2. The road, if on slope, should be placed where the dip of the strata leads the water from the road whenever conditions will permit.

3. Roads should be placed, when practical, on slopes which are exposed to the sun in the winter, so as to reduce the number of days the roads will be covered with ice.

4. Curvatures should be kept to the lowest degrees possible so that the longest obtainable sidelines may be had.

5. The roads should be located above high water when conditions will warrant.

6. The grades should be the best that topography will permit.

7. For horse-drawn vehicles, distances should yield to grade.

8. For motor vehicles, alignment and surface may take precedence over the grade, but grade must be considered.

9. Direction of the traffic and the kind of freight produced in the community should be considered.

10. The nature of the future development of the territory should also be noted.

11. The general bearing the improvement will have on the other sections of the state and nation, should be studied and applied to the general plan.

12. In short, everything to make the road of the greatest service at the lowest cost, should be done so far as possible and practicable.

Recent Developments in Design and Construction of Pavements in Chicago

By H. J. Fixmer, Paving Engineer, Board of Local Improvements, Chicago, Ill.

During the year 1918 several changes in pavement design were adopted or improved and successfully realized in practice in Chicago.

Crown

To accommodate present and future vehicular traffic which is becoming entirely self propelled, more attention has been given to fitting the paving construction to the new traffic needs. A new form of crown line or surface contour has been adopted which is shown graphically in Fig. 1. Instead of the familiar parabola a flatter curve is used. In Fig. 1 the position of the new crown line with reference to a parabola having the same depth of gutter at the curb and an equivalent parabola passing through the shoulder or quarter point is plainly shown.

The advantages of the new form of crown curve may be outlined as follows: It increases the cross drainage near the middle of the roadway. It permits a reduction of total crown slope of at least 25%. It secures a more satisfactory surface

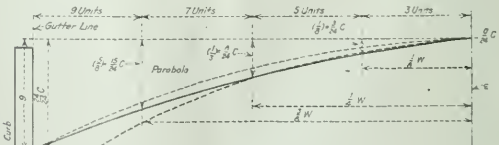


FIG. 1. NEW CROWN SECTION, CHICAGO PAVEMENTS.

from the standpoint of construction, drainage and use. The reduction of slope near the gutter adds to the safety of traffic and thus increases the width of effective or "available" roadway. By securing a wider distribution of traffic the life of the pavement is prolonged. On very wide roadways the slope from the quarter point to the gutter may be further advantageously decreased by substituting a straight line slope for the usual curve slope.

It will be seen from Fig. 1 that the decreased rate of crown slope results in a saving in the cost of excavation, which is no

mean item when the cost amounts to one to two dollars a cubic yard, as it has the past year in Chicago.

Curb Corners

The radius of curb corners has been increased. The standard for the typical residence street is a 10 ft. radius at street intersections and a 6 ft. radius at alley returns. For business streets the general radius of 6 ft. is employed for both street and alley corners.

On wider streets and streets having certain kinds of traffic predominating larger radius corners are being used.

This improvement has the following advantages: It adds to the convenience and safety of traffic; it improves the appearance of the intersection, and reduces the destruction of curbing at the curb corners. While the area of pavement is increased, the amount of curbing is reduced. The difference in cost is money well spent. The combined curb and gutter used in Chicago has a curb 7 ins. thick and a gutter 8 ins. deep and 12 ins. wide. This section has proved amply strong and is now standard construction. Table 1 shows the "minus curb" and "plus pavement" for one curb corner of radii from 3 to 25 ft. This table is convenient when preparing estimates and determining fatal quantities. Columns 4 and 5 give plus area of pavement where straight curb is used, and columns 6 and 7 where a curb and gutter is used.

Depth of Gutter

The depth of the gutter below the top of the curb has been reduced. Where combination curb and gutter is used this improvement results in a saving in cost of curb and gutter, a neater appearance and less breakages of curb.

On all streets, this elevation of the pavement, as it were, results in a saving in amount of excavation and furnishes more support to the curb on the roadway or pavement side. Consideration is being given to the use of a uniform section of curb and gutter, having a low curb, on narrow residence streets.

Street Crossings

On residence streets pedestrian traffic is rendered safe and convenient by reason of paving the cross walk at street intersections and at alley returns even with the top of the curb for a distance equal to the width of the adjacent sidewalk. This eliminates the old step and dangerous gutter opening formerly used, which was a source of accidents and damage suits against the city.

By reason of using a flatter crown section, larger radius corners and a low crown height at street intersections, this improvement in street crossing is readily effected without inconveniencing vehicle traffic.

General

Concrete foundation is used under all types of pavement except macadam. It is usually a 1:3:6 mix, varying from 6 to 8 ins. in depth, depending on the traffic and the condition of the subgrade. Asphaltic concrete (Topeka mix) has been abandoned because of its general failure due to lack of stability. The depth of the binder course on sheet asphalt pavements will probably be increased to furnish greater stability to meet heavier traffic conditions. Brick pavements are laid with a mortar cushion 1 in. thick and a filler of grout or preferably asphalt. Tar filler is not specified. The asphalt filler protects the edges of the brick and forms a mat wearing surface which fills any inequalities in the surface and thus maintains a smooth, durable surface. On car line streets three or four rows of granite block are laid parallel with the rail. The granite withstands vibration and takes the excess wear occasioned by the vehicles turning off and on to the car tracks. Sandstone blocks are being specified on heavy traffic streets where the grade exceeds 2 percent. It affords safe traction and wears smooth.

TABLE I—LENGTHS OF CURB AND PAVEMENT AREAS FOR ONE CURB CORNER FOR RADII FROM 3 TO 25 FEET.

By H. J. Fixmer, Division Engineer, Board of Local Improvements, Chicago, 1918.

Radius of Curb Corner In Ft.	Length of Curb (¼ Circum.) Lin. Ft.	Minus Curb Lin. Ft.	Plus Area of Pavem't (One Curb Corner) Straight Curb Sq. Ft.	Sq. Yds.	12 in. Wide Gutter Sq. Ft.	Sq. Yds.
3	4.71	1.29	1.93	0.21	3.43	0.38
4	6.28	1.72	3.43	0.38	5.36	0.60
5	7.85	2.15	5.36	0.60	7.72	0.86
6	9.42	2.58	7.72	0.86	10.52	1.17
7	11.00	3.00	10.52	1.17	13.76	1.53
8	12.56	3.44	13.76	1.53	17.63	1.96
9	14.14	3.86	17.63	1.96	21.46	2.38
10	15.71	4.29	21.46	2.38	25.97	2.88
11	17.28	4.72	25.97	2.88	30.90	3.43
12	18.85	5.15	30.90	3.43	36.27	4.03
13	20.42	5.58	36.27	4.03	42.06	4.67
14	22.00	6.00	42.06	4.67	48.28	5.36
15	23.56	6.44	48.28	5.36	54.94	6.10
16	25.12	6.88	54.94	6.10	62.02	6.90
18	28.28	7.72	69.52	7.72	77.50	8.60
20	31.42	8.58	85.85	9.54	94.65	10.52
25	39.27	10.73	134.12	14.99	145.10	16.12

Construction

Probably the most noteworthy innovation in construction the past year was the mixing of concrete for the pavement base at a central plant and hauling the concrete in motor trucks to the streets under construction. On the job in question about

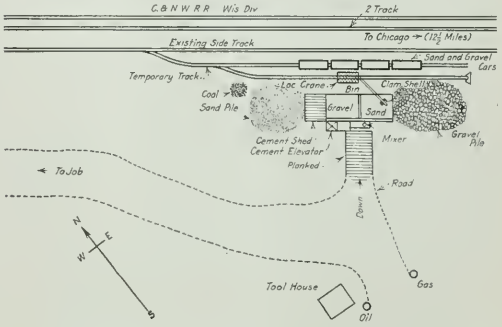


FIG. 2—CENTRAL CONCRETE MIXING PLANT LAYOUT. CONCRETE HAULED FROM PLANT TO STREET UNDER CONSTRUCTION IN MOTOR TRUCKS.

13,500 cu. yds. of 1:3:6 mix concrete were handled. The base was 6 ins. thick and amounted to about 80,500 sq. yds. The width of roadways on this system of streets was proportioned according to the traffic need or character of frontage, and were 18, 24 or 30 ft. in width.

The mixing plant was installed alongside a temporary siding off the main line of the C. & N. W. Ry. (See Fig. 2.)

The plant required two temporary switch tracks, on one of which a locomotive crane operated, transferring the sand and gravel from the cars on the adjacent track to two elevated bins of about 50 cu. yds. capacity. In addition to the bins, large stock or storage piles were built up to anticipate car shortage.

Adjoining the bin on one side was a ground level cement storage shed. The mixer was erected on the side of the bins away from the switch tracks, with the discharge chute about 6 ft. above the ground. In front of the mixer a depressed planked road was built to enable the trucks to back in and receive their load. The cement was raised onto the charging platform by an improvised elevator, which was hoisted and lowered by a rope attached to the drum which ordinarily operates the charging hopper of the mixer.

The engine man on the mixer operated the elevator, admitted the water and lowered and raised the discharge chute. The sand and gravel were proportioned in an old asphalt measuring box, which was divided by a plate set one-third the over-all length from one end. It held 6 cu. ft. of sand and 12 cu. ft. of gravel, which was discharged into the mixer along with two bags of cement. One man operated the chute doors that filled the measuring box and likewise released the contents of the box into the mixer. The standard batch was a two-bag batch and produced ½ cu. yd. of concrete.

The concrete was hauled by Mack trucks, four, five or six being used, depending on the haul, which averaged less than a

mile. The time of haul from mixer to street varied from 10 to 20 minutes. Each truck carried four batches, which would lay 12 sq. yds. of base. A fair day's average was 1,800 sq. yds., with a maximum of 2,250 sq. yds.

When the trucks reached the subgrade they were backed onto the previously laid concrete a distance of about 4 ft., and then dumped from the end by elevating the body. In this way the slush, which occasionally separated from the concrete mass, was automatically spread over the concrete in place and not wasted. To facilitate dumping and prevent an excessive separation of the aggregates a division plate was built at an angle of 45 degrees near the forward end of each truck.

There was practically no leakage and the concrete was a uniform and generally excellent product. The crews at the plant and on the street were about equal, each having, as a rule, 10 to 12 men.

The type of trucks used was the standard 7½-ton Mack truck, equipped with bodies designed to carry asphalt mixtures. They proved highly efficient and not only served to overcome the shortage of labor that prevailed at the time, but were instrumental in effecting considerable saving to the contractor. The same type of trucks was used to haul the sheet asphalt surfacing from a plant about 5 miles away.

The use of grading machines increased the past year. Many different types were used, depending usually on the amount or difficulty of the cut. The scarcity of dumps, together with the increased cost of labor and teams, caused prices to increase regardless of all economies secured through the use of machines.

The mileage of pavement laid during 1918 was about one-half the normal mileage, and was divided as follows:

Sheet asphalt	41.53 miles
Asphalt macadam	8.86 miles
Brick	10.23 miles
Concrete (alleys)	14.43 miles
Creosoted wood block	1.01 miles
Granite block	.71 miles
Total	76.77 miles

Some Conditions Observed in Public Utility Plants by a Representative of the U. S. Fuel Administration

By Charles Brossman, Consulting Engineer, Power and Utility Plants, U. S. Fuel Administration, Merchants Bank Bldg., Indianapolis, Ind.

There are no restrictions on coal at present. The utility plant can uses all it wishes—at the price. However, with so many utilities during the past year asking for surcharges, we find the main reason is increased operating expense, with fuel as one of the main factors, so that it is quite evident that the price of fuel is still of considerable importance. Granting this, some of the things found in utility plant practice by the U. S. Fuel Administration were peculiar. The conditions found are not necessarily confined to municipally owned plants, but in the private plants as well, although probably not to such a great degree, said Mr. Brossman, in addressing the Indiana Engineering Society.

It is of interest to note the following encouraging news item from a paper of only a few days ago, in which one large company withdrew its plea for a rate increase, stating that they had determined to see if they could overcome some of their excessive expenses through reduction on the price of coal and better operating conditions. This is a gleam of encouragement, and it is to be regretted that this stand has not been taken more often, at least to endeavor to cut down expenses partially, so that the surcharge asked, where necessary, need not have been so great.

Means of Reducing Expenses

There have been several means of reducing expenses in utility plants. These can be divided into two general classes—one the matter of interconnection between utility and power plants, where in one case the larger plant will usually be more economical of operation and where the interconnection would result in the saving either of fuel or labor or both. The other is the question of reducing operating expenses.

Interconnection of Utility and Power Plants

The mere fact that interconnection could be made between a smaller and larger plant does not necessarily mean that there would be a saving. A number of such cases have been carefully investigated, and in some cases it has been found possible to save and in others the interconnection would show even a greater fuel consumption.

Examples

I am going to mention a few of these instances. In investigating a utility on the question of interconnection, the practice was made to get all possible details of operation and in numerous cases actual tests were conducted on the plants in question, so that the possible fuel saving could be determined. The fuel administration was not concerned in the dollars and cents saving, but the main object was the conserving of fuel, but with this information determined it then became an easy matter for the plants concerned to find out what the saving in money would be.

Lack of Foresight

One thing that stood out very plainly in some of the plants, was the lack of engineering foresight used and emphasis should be placed on the fearlessness with which some public

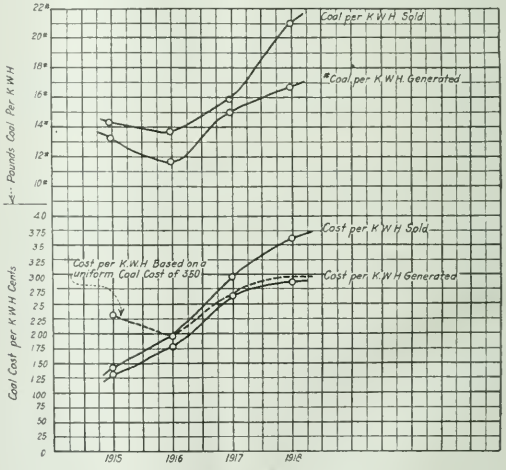


CHART NO. 1.

officials had determined off hand engineering problems that a competent and trained engineer might spend several weeks in investigating and figuring in order to get the best results.

Lack of Records

Another was the method of operating some of these plants without records of any kind, without any effort to determine costs and with no knowledge whatever of the comparative results of their plant as compared with others. In one instance, the superintendent of the light plant was not allowed in the power house and could only look after the street equipment. The power house was looked after by one of the public officials and changes were being made that at that time seemed absolutely unnecessary.

One place the designer was abused for putting in a certain recording device, and yet the device was not operating, although it was of fine, standard equipment, but absolutely no records were kept and the question of rates were up at that time for an increase. Just think of a plant using anywhere

from 16 to 20 lbs. of coal per K. W. (see Chart 1) and selling current to the water department for 30 per cent. less than it cost to make it. Here the current was generated by a small generator operated by a slide valve engine, running with a back pressure and then pumping water with a motor and centrifugal pump, while right in the plant stood a compound pumping engine, on which the overall steam rate for pumping would have been considerably less than on the centrifugal.

What encouragement is there to an operating engineer, who is ordered to discontinue keeping records? Is it any wonder that such plants should be using almost twice as much coal as necessary. On questioning the fireman, he said he had only worked there three days and I believed him for I counted 27 shovels full of coal going under that boiler at one time.

Investigating Suggested Interconnection

In another plant the question of interconnection was brought up and careful tests were made on both plants considering the interconnection. This was a municipal light and water plant, and interconnection was considered with a much larger private utility. Loads of both plants were carefully taken and actual coal tests made under several different conditions and in this plant it was found that a saving of almost 1,000 tons a year could be made. In this plant, which was a municipal plant it is commendable that the superintendent had already previous to this, cut down his coal consumption on the electric end to a considerable degree, so that the saving of about 1,000 tons a year, was what was shown after increased economy in the plant had been obtained.

The main reason for this further saving, was in the difference of the size and loading of the machines in the two plants. The large plant having almost three times the capacity of the smaller plant. In this case, the smaller plant was operating at only one-quarter load and they were using for this work about 6,000 lbs. of coal to make the run during the night. A test operated on the larger plant with them pulling the additional load to their own, showed that only 1,000 lbs. additional coal was used to do this same work. (See Chart 2.) This was due to the fact, that their night load was poor and adding this additional load, it gives them a much better load factor. It is of interest to note however, that even in this larger plant, no scales were used for weighing coal until the fuel administration asked for this test.

In this case the question of electrical pumping was not considered, as no coal saving would have resulted, due to the fact that the municipal plant was pumping its water with a compound Corliss condensing engine and was using less coal than would have been used by the larger plant to pump electrically .

Chart 2 shows the curve on a test 750 K. W. H. turbine. This test is of interest as from the coal used and the loads taken for 60 hrs., an average curve has been drawn, which shows the overall station efficiency. It is of interest to note that the total coal consumption divided by the total K. W. H. load, coincides with the average curve drawn.

As there may be some who might not understand how we get the 1.12 lbs. coal per K. W. H., this is figured as follows:

	K. W. H.	Coal.
Load with street light load	2,920	21,000 lbs.
Load without street lights	2,040	20,000 lbs.
Used by street lights	880	1,000 lbs.

It will thus be seen that to carry the 880 K. W. H. for street lights, it requires 1,000 lbs. of coal or 1.12 lbs. coal per K. W .H. It must be remembered that this is not the overall pounds per K. W. H., but it is the proper figure to use for comparing the coal saving, between this plant and the other plant.

Steam Pumping Sometimes Most Economical

There seems to be among a good many central station men, the idea that any electric pump can be operated more economically than any steam pump. This may not be the case. Of course, where labor is saved, that will some times offset what might be lost on coal. I wish to mention a case where considerable agitation had been made to pump the water of the municipal plant and in this case, the considered interconnecting company had a fair sized plant, but it was found that for them to furnish current for pumping, as compared to the city's steam pump, would have resulted in an actual loss of fuel and it was pretty hard to convince the company officials that such would be the case. This was apparently due to the fact, that they did not realize that a high duty crank and fly-wheel condensing pumping engine, had almost as low a water rate as their large electric unit. However, they were finally though reluctantly convinced.

In another instance of interconnection on water plants, it was found and recommended that electric driven centrifugal pumps as compared to the old non-condensing duplex, would result in a saving of fuel and labor, that would pay for the investment in a little over four years time. In this case, the city went ahead and made arrangements to change over.

From the above it will be seen that there is only one safe thing to do and that is to investigate every case carefully.

Some Good Plants

It must not be thought all the plants examined are horrible examples. Some of the medium sized plants found in the state, were operating as low as 4½ lbs. of coal per kilowat. In this plant last mentioned, the manager has well kept records

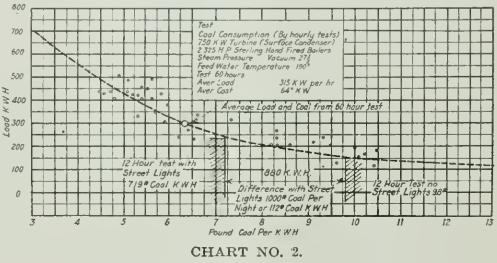

Test
Coal Consumption (By hourly tests)
750 K W Turbine (Surface Condenser)
2 325 H P Sterling Hand Fired Boilers
Steam Pressure Vacuum 27"
Feed Water Temperature 190°
Test 60 hours
Aver Load 515 K W per hr
Aver Cost 64° K W
Average Load and Coal from 60 hour test
12 Hour test with Street Lights 7.8# Coal K W H
880 K W H
Difference with Street Lights 1000# Coal Per Night at 1.12# Coal K W H
12 Hour Test no Street Lights 30#
Load K W H
Pound Coal Per K W H

CHART NO. 2.

of all loads and conditions and he could give on a moment's notice any information regarding the operation of his plant.

It is rather interesting to know that most of the plants that keep no records and have no means of determining what they are doing are the uneconomical plants. I recall an installation, which reminded me of the way a green Irish conductor rang up his fares. "Here, Mike," said the inspector, "you have ten passengers and nine fares." "Is that so," said Mike, "then there is too many of ye on the car, one of yez get off of here." In this particular boiler plant, I think of, they had the scales, coal cars and water meter, but the firemen only went through the action of weighing and taking the water records, and put them down so that they looked "about right."

Burned Coal to Keep Cars Moving

Another instance, one operating engineer said he had been jumped by the Councilmen, because he did not get the cars of coal off of the switch fast enough, as they had no place to store it. "The other engineer burned it faster than you do and I do not see why you can't do it," was the argument.

In one plant the records were fairly well kept, it was found that they were using from 6½ to 7½ lbs. of coal per K. W. H. generated and which looked fairly good on the face of it. An analysis of the boiler flue gases, only showed about 4 to 6% CO_2. It is quite evident that with such a showing, there is no reason why the coal per K. W. H. should not be further reduced and this is being accomplished in this particular plant. Some of the plants visited had the necessary equipment to take the proper tests, but despite the fact, they claimed that they were losing money without trying to better conditions as they should have done.

Improper Operation

An analysis of the trouble of many of these plants shows that a large part of their loss is due to improper boiler room operation and not keeping the proper records or properly analyzing them. There have been many plants where from 10 to 20% saving in coal could be made, simply by changes in operating methods. This is one of the important lessons that should be taken advantage of.

Another most important thing is the method in which new equipment is purchased, without any analysis of operating loads and conditions and on the hit and miss theory. This trouble comes more from the municipal plants, although a number of such cases were found in the private utilites. I make the assertion that thousands of dollars are wasted every year in municipalities, by improper purchasing without expert engineering advice and without careful engineering analysis of the true conditions.

Conclusions

The important lessons shown from the fuel administration work are:

That too little attention is paid to the proper and economical operation of the plant, as pertaining to the boiler room, as the greater proportion of loss of the plant seems to take place in the manufacture of the steam.

That interconnection in numerous cases would be advisable, owing to the character of equipment, and combined with better methods of operation, where economical central stations have power available, advantage should be taken of the possibility of interconnection, when these uneconomical plants can be placed on a sound basis.

That an important reason for low economy is the method of purchasing new equipment and making additions to plants without any regard to the adaptability of the units purchased. More attention should be given to getting the exact working conditions of the plant and paying more attention to economical machinery and purchasing new plant equipment.

I believe that the time has been reached on public utility plants with any kind of power plant, where strict attention must be given to proper design and purchase and more accurate methods of operation. If such things were looked after, there would be much less trouble and fewer failures in such plants.

Baltimore Adopts Feeding for Disposal of Garbage

By Walter E. Lee, Water Engineer of Baltimore, Md.

A feeding contract for the disposal of garbage was awarded by the city of Baltimore on Dec. 21, 1918, for a period commencing May 1, 1919, and ending Dec. 31, 1923, under which the contractor will pay the city an annual sum of approximately $31,500. Barging and towing costs reduce this by $15,000, leaving an annual net return of $16,500.

Studies Made

The city of Baltimore for over two years made extensive studies and exhaustive investigations on the method of refuse disposal which were best suited to the local conditions and the writer in a report of Jan. 28, 1918, to Mayor James H. Preston, recommended that garbage be disposed of by reduction in one central plant, ashes by filling ravines, low marshes and swampy ground along the water front for reclamation of land, and rubbish by incineration of the combustible portions, except the recoverable merchantable articles, in three municipal incinerators.

Former Disposal Methods

The history of garbage disposal in the city of Baltimore has been successively dumping on ground, reduction and finally feeding. From 1882 until 1901 the garbage was barged to a point six miles below the city by a contractor and there spread over the ground as a farm fertilizer.

A contract for ten years was awarded commencing Oct. 20, 1902, at an annual payment to the contractor of $147,300, for the collection, removal and disposal of garbage and a reduction plant employing the Arnold-Edgerton system of digestion was erected in the heart of the city near the water front, to which the collection carts of the contractor made a direct haul.

Complaints on the non-collection of refuse became so numerous and objections to the odors from the reduction plant were so strong, that the city terminated the contract on Jan. 1, 1908, and purchased the collection equipment and reduction plant from the contractor at the price of $372,888.19 and placed directly under the commissioner of street cleaning the collection and removal of garbage from residences.

A second reduction contract was awarded in 1908 for ten years, terminating Dec. 31, 1917, at an annual payment to the contractor of approximately $75,000. A new company was organized and the reduction machinery leased from the city at an annual rental of $10,000. At the expiration of this contract, it was extended for a period of one year until Dec. 31, 1918, at the request of the city, under which extension no rental was paid for the use of the city's machinery, so that the cost of disposal in effect amounted to $85,000.

Recovering Values

The specifications recently issued by the city contemplated in the disposal of garbage:

1. That the garbage should be utilized in some way to recover the values contained in it, either by the production of grease and tankage or by increasing the weight of hogs.
2. That the method of disposal should be sanitary in all respects and not liable as a nuisance.
3. That a payment per ton be made to the city for all garbage delivered to the contractor.

Specifications Covering Reduction Method

The first specifications for disposal by reduction in furtherance of the recommendation of Jan. 28, 1918, were advertised in March and opened on April 17th, 1918. It asked for proposals offering a lump sum payment year by year to the city under an eleven year contract and obligated the city to deliver to the contractors all garbage produced from all sources within the city of Baltimore.

The specifications defined garbage as being every accumulation of animal, fruit or vegetable food waste, containing not more than 5% by weight of other refuse, generated by or resulting from the decay, deterioration, storage, preparation or handling of animal or vegetable matter in any place or at any point where food is prepared for human consumption, including all kitchen and dining room refuse.

The contractor was required to receive the garbage at the water front dumping stations provided by the city and convey it on his own scows and by his own power to the site of the reduction plant.

The specifications stipulated that the garbage should be handled and disposed of under a "closed" system of reduction so as to prevent the emission of offensive odors of any kind while being handled, treated or reduced, and that the process, machinery and apparatus be thoroughly sanitary in effect and the plant so conducted as not to cause conditions which would be detrimental to the public health or comfort, or in any way constitute a public nuisance.

All gases carrying odors which were produced or resulted from the operation of the process, machinery or equipment used, were to be confined and before being liberated to the atmosphere were to be thoroughly deodorized. All water flowing from the plant was to be inoffensive, free from nuisance dangerous to the public health or to the oyster beds in the Chesapeake Bay or its tributaries.

It was further specified that the city should have the option of purchasing the plant and equipment from the contractor at the expiration of the contract, and that the reduction site should contain not less than 5 acres, situated on at least one railroad or above high tide on a navigable waterway.

Bids Asked and Received

Under the first specification a flat offer of 35 cts. per ton was received which would employ the Cobwell process of reduction but the city failed to secure the approval of the Capital Issues Committee on the necessary stock issue for the erection of a plant of 350 tons per day capacity, and the bid was subsequently released.

A second specification was advertised on Oct. 2, and opened Oct. 16, 1918, under which the city obligated itself to do the same things as in the previous specifications and asked for alternate proposals on disposal by reduction or disposal by feeding. The reduction contract was for 16 years and offered the prospective bidders, without charge, the use of machinery which the city owned in the existing plant for re-erection and operation in a temporary plant until the end of the war, after which a permanent plant was to be erected. The contract for feeding was for 5 years. No bids were received under either reduction or feeding.

A third specification was advertised on Dec. 6, and opened Dec. 18, 1918. Under this specification the city undertook the delivery of garbage from the water front stations to the contractors' disposal site, as the city realized that the collection and removal of garbage from its water front dumping stations was simply an extension of the collection and removal from the residences, and a matter in which the contractor has no primary interest. The towing of garbage was a proper function for the city to undertake, for when any contractor is required to undertake it, the public at large is not always satisfied with the way in which the work is done, but when done by the city the public always has the proper remedy for getting a quick and adequate response to its complaints on the accumulation and non-removal of garbage from the water front stations.

An act of the Maryland Legislature prohibits the erection of a garbage reduction plant within a nine mile radius of Lazaretto Light, a shore light in Baltimore Harbor, and consequently any possible site for such a plant would involve a barging distance of 16 miles from the water front dumping station in the city and 4 hours of towing either way.

Alternate proposals were again asked on disposal by reduction or by feeding. The term for reduction was 16 years and a flat price per ton was requested with an adjustment, to be stated by the bidder, in cents per ton for every upward or downward fluctuation in the market value of grease from a basic price of 8 cts. per pound, as the city felt that it should share this risk with the contractor so that all elements of gambling in making a bid should be entirely removed.

The term for feeding was five years, commencing May 1, 1919, and bids were requested on an annual flat payment to the city for each ton of garbage delivered to the feeding site.

No bids were received under disposal by reduction, and one bid was received under disposal by feeding. The contractor operating the present reduction plant made no formal offer.

Contract Awarded for Disposal by Feeding

A contract was awarded on Dec. 21, 1918, for disposal by feeding and the price to be paid to the city for each ton of garbage delivered is 3½ times the price per pound of live killing hogs on the Chicago market, as determined by averaging the top prices for each month. The scales for weighing the garbage are located at the feeding site and all garbage is drained before weighing.

Temporary Disposal by Burial

Until May 1, 1919, at which time the piggery shall take the full quantity of garbage produced, the city of Baltimore with its own forces will temporarily dispose of its garbage by burying it in shallow trenches 18 ins. deep and 5 ft. wide, in which the garbage is placed 12 ins. thick and covered with 6 ins. of sandy soil. There will be 17,000 lin. ft. required to accommodate this temporary disposal of garbage until the piggery is in operation. The cost of the temporary disposal is 85 cts. a ton against a former cost of $1.06 per ton under reduction, the towing cost being included in both figures.

Contract Provisions

The contractor pays for all household garbage delivered and for those portions of market refuse derived from an animal source, but not for that from a vegetable source or for any packing-house refuse.

The city obligates itself to enforce good primary separation and to deliver the garbage in as fresh a condition as possible to the feeding site, with not less than four deliveries per week in summer and three deliveries per week in winter.

The contractor is given the privilege of using the empty city scows, without charge, on their return trip to the city for the transportation of the products of the piggery.

The 160 acre farm, on which the feeding operations will be conducted, is almost level and has sandy soil insuring good drainage with considerable water through an extensive shore line. Scrub pine, chestnut and oak timber affords protection from the summer heat. The farm is owned by the city and was purchased at an average price of $140 per acre. It is situated on a point on the opposite side of the tributary of the Chesapeake Bay on which the existing garbage reduction plant is located and this proximity to a plant which has been operating 11 years without any formal complaint or restraint, will insure a like operation of the piggery.

The specifications require that the piggery shall be operated subject to the general and local public laws and under the supervision of such veterinarian and sanitary officers of the county and state having proper jurisdiction.

The city will also employ a veterinarian who shall have continual supervision and inspection over the work of the piggery.

The garbage which is unfit for feeding or not consumed shall be removed from the feeding platforms, which shall be cleaned at least once a day, and disposed of by the contractor through sale or by plowing under the soil.

The area of Baltimore is 80.5 square miles and the estimated population, with the recently annexed territory, is 720,000. The quantity of garbage produced and the seasonal fluctuation is shown in the accompanying tables.

The Hogs

It is estimated that 15,000 hogs will be required to consume the maximum amount of garbage produced during the summer peak and it will probably represent the largest piggery in the world and Baltimore will be the largest city of the United

TABLE I—YEARLY COLLECTION OF GARBAGE AND DEAD ANIMALS, IN TONS, OF BALTIMORE, MD., 1908 TO 1918.

Year	Garbage Production, Tons	Number of Dead Animals	Estimated Population
1908	54,000	13,754	569,000
1909	46,900	14,637	576,000
1910	44,500	17,790	559,000
1911	48,300	19,792	565,000
1912	49,200	20,498	568,000
1913	54,400	16,561	573,000
1914	59,100	15,993	578,000
1915	61,500	14,459	583,000
1916	62,400	17,419	588,000
1917	62,300	20,178	593,000
1918	51,324	16,464	670,000

TABLE II—MONTHLY FLUCTUATION IN GARBAGE PRODUCTION AT BALTIMORE FOR THE YEARS 1917 AND 1918.

Month	1917, Tons	1918, Tons
January	4,566	3,272
February	3,089	2,081
March	3,594	3,030
April	3,334	3,081
May	4,979	4,570
June	5,475	4,207
July	7,577	5,570
August	7,399	5,267
September	6,886	4,904
October	7,096	6,657
November	4,517	4,392
December	3,749	....
	62,261	*51,324

*Estimated from eleven months' collection.

States which has adopted this method for its disposal of garbage.

Young shoats, vaccinated with cholera serum, will be purchased in the open market and shipped to the feeding station, where approximately 100 animals will be placed in feeding lots, 70 x 250 ft. in size.

The Handling Equipment

Garbage will be unloaded from the city's scows at the feeding site by the contractor by the use of a locomotive crane with a grab bucket of 1 yd. capacity.

The garbage will be dropped into steel rocker double-side dump cars of 10 yds capacity each, on an adjacent track and hauled by an oil-burning locomotive directly down a lane between the feeding lots.

The end of the feeding lots adjacent to the railroad will have a monolithic concrete feeding floor from which the animals are excluded by wide gates when the garbage is being dumped from the rocker-side dump cars.

When the train has traveled to the full length of its trip, the garbage will be spread on the return trip to the wharf by a spreader from the rear end of the train, after which the gates will be opened and each lot of hogs allowed to enter on the concrete feeding floors to eat the garbage.

Conclusion

Disposal of garbage by feeding involves a relatively small capital investment which can be quickly and almost wholly liquidated at the expiration of the contract and in this respect differs from all reduction plants in which the machinery is of little use for any other purpose and possesses only a scrap value.

Feeding is a reliable method and one which offers the highest financial returns to a municipality. It is absolutely essential, however, that the responsibility of the bidder be determined beyond the shadow of a doubt, which is usually satisfied when there is sufficient training in animal husbandry and practical experience by the bidder in previous sucessfully managed piggeries.

Efficiency of Bituminous Surfaces and Pavements Under Motor Truck Traffic

By Prevost Hubbard, Chemical Engineer, U. S. Bureau of Public Roads

The title of this paper covers a subject upon which a great deal of thought has been spent by progressive highway engineers as applied to pre-war traffic conditions and its progressive normal development. Many engineers had, at least in their own minds, classified the various types of pavements with relation to their efficiency under ordinary variations of traffic encountered on county, state and municipal highways and their ideas were fairly well fixed on the subject as evidenced by more or less consistent practice in their choice of types when reconstruction or new construction became necessary.

Old Rating of Bituminous Types

Just where the dividing line should be drawn, so far as traffic is concerned, between different types of pavements has always been a matter of individual opinion, but in general with increases in volume of weight of traffic the increasing efficiency of the bituminous types has been rated as follows:

1. Bituminous Surfaces.
2. Bituminous Macadam.
3. Bituminous Concrete.
4. Sheet Asphalt and Asphalt Block.

Traffic Changes

Suddenly and with little opportunity for anticipation, a very large mileage of our important state highways and many of our local county and municipal pavements were subjected to a tremendous increase in traffic. This increase was not only in volume, which would have presented a comparatively simple problem to solve, but in the weight and load carrying capacity of the individual vehicle. This, coupled with an unusually severe winter and immediately followed by war restrictions upon the use of many road materials, labor shortage, excessive costs, and loss of members of highway engineering organizations, created a situation during the year 1918 which was abnormally serious and complicated. With compartively few exceptions, new construction ceased and maintenance was so handicapped as to become inadequate.

Road Failure Under Truck Traffic

Hundreds of miles of roads failed under the heavy motor truck traffic within a comparatively few weeks or months. Roads with bituminous surfaces, bituminous macadam roads and bituminous concrete roads all failed alike, together with other types used in state and county work. These failures were not only sudden but complete and almost over night an excellent surface might become impassable. Such rapid and complete failures in municipal pavements were of less common occurrence and as sheet asphalt and asphalt block have always been largely confined to municipal work, failures of these types have not been noted to the same extent as the other types mentioned.

Simultaneous Destruction of Entire Road Structure

In the haste and confusion of war activities little opportunity has existed for a systematic and comprehensive study of the problem suddenly thrust upon highway engineers. Reports from all parts of the country have, however, established one outstanding fact which has a most important bearing upon any consideration of the efficiency of bituminous surfaces and bituminous pavements. A very large proportion of the failures have been characterized by an almost simultaneous destruction of the entire road structure, and not merely the disintegration of the wearing course or pavement proper. No type of pavement will be efficient unless provided with a foundation which will hold up the pavement until it is worn out. When, therefore, the entire structure fails suddenly, inadequate subgrade or foundation conditions are primarily responsible and but little basis exists for placing an efficiency valuation upon the wearing course.

Foundation Failures

Inevitably coupled with subgrade and drainage conditions, foundation failures occurring as previously described may be due to one of two causes, lack of thickness, or inability of the foundation structure to sustain the loads without appreciable internal movement. So far as bituminous surfaces or bituminous pavements are concerned, remedy of the first cause does not affect the general type of construction.

If, however, present heavy motor truck traffic is to continue and possibly increase in weight as well as volume the second cause may have a direct bearing upon possible modifications in design and in the ultimate determination of the efficiency of certain classes of bituminous work. Most subgrades have a much lower carrying capacity in the spring than at other periods of the year. As there is practically no slab effect produced by the structure of a broken stone or gravel foundation, a load applied to any overlying bituminous surface is transmitted quite directly to the subgrade. In other words, the intensity of load under its point of application is relatively high throughout the foundation thickness.

Under heavy motor truck traffic the intensity of load transmitted through a 2 in. thickness of dense bituminous concrete to the foundation may be so great as to cause an internal movement sufficient to produce disintegration of the pavement. This is particularly true when the subgrade is of a soft or clayey nature and appears to be quite possible irrespective of any economical thickness of broken stone or gravel foundation which may be used.

In general, the experience on heavily traveled city streets has demonstrated the necessity of a slab foundation for any wearing course and there appears to be no reason why such experience should not serve as a guide for new construction

of bituminous pavements on state and county highways subjected to modern heavy traffic. On these highways the traffic has certainly been as severe as on many city business streets, so far as weight of unit loads is concerned, and more severe when the high speed often attained by such traffic is considered.

Surface Treatment with Bituminous Materials

With respect to existing gravel and macadam roads, whether or not they have been previously surface treated with bituminous material, it would seem far safer at the present time to attempt to preserve such roads under heavy motor truck traffic by means of surface treatment with bituminous materials rather than to utilize them as foundations for the construction of new bituminous macadam or bituminous concrete pavements. In other words, for the time being such treatments may prove more efficient than the use of a higher type of pavement placed upon the existing road, although it is clearly recognized that, under heavy motor truck traffic, the bituminous pavements are more efficient providing the foundation is adequate to support the loads.

Climatic Influences

Under the same conditions of traffic bituminous surfaces are most efficient in localities where frost action is either absent or not severe. Such treatments used in connection with gravel roads adjacent to army cantonments in the far South have given reasonable satisfaction even under heavy motor truck traffic. North of the frost line and particularly in connection with the treatment of clayey gravel roads, which become soft during the spring months, bituminous surfaces are apt to disappear completely. If, however, the gravel road is maintained by dragging and at the end of the thawing out period is reshaped, thoroughly compacted and again treated with bituminous material, it may be kept in a reasonably satisfactory condition.

Under very heavy motor truck traffic, however, maintenance costs may be extremely high so that if a continuation of such traffic is to be expected the construction of a new road may be necessary. Thus, during a period of 120 days on a clay gravel road leading from Alexandria to Camp Humphreys, Virginia, which was subject to an average daily traffic of some 230 heavy motor trucks, the cost for maintenance amounted to approximately $10,000 per mile. Because of this enormous expense the construction of a new type of road became necessary.

Failure of Base

In connection with this road it is of interest to note that prior to its maintenance as a gravel road, it had served as a 6 in. foundation for a dense bituminous concrete pavement 2 ins. thick. This pavement has successfully passed a year of ordinary country and pleasure traffic carrying a large number of touring cars between Washington and Mt. Vernon. In the spring of 1918, it was suddenly subjected, to an average traffic of over 200 heavy motor trucks a day and within a comparatively few weeks was absolutely ruined, due to failure of the foundation during the thawing out period. An extension of this road in the city of Alexandria consists of a number of sections of very carefully constructed bituminous macadam laid some years ago upon a concrete base. Although subjected to the same heavy traffic, the bituminous macadam, ordinarily considered less efficient than bituminous concrete, did not fail except in a few places where failure of the concrete base could be held responsible owing to exceptionally poor subgrade conditions.

Bituminous Surfaces on Macadam Roads

Bituminous surfaces on properly constructed macadam roads subjected to heavy motor truck traffic may, as a rule, be maintained in localities north of the frost line with less expense and better results than on gravel roads under the same conditions. Such surfaces, under heavy motor truck traffic, cannot be considered as economical from the ordinary standpoint but may prove the most efficient temporary method of preserving the existing road until money is available for reconstruction. It is believed, however, that under these conditions bituminous surfaces will not even prove efficient unless constantly maintained by a patrol system operating throughout the year.

Maintenance by the Bureau of Public Roads of experimental bituminous surfaces on the Rockville pike, Maryland, which is a macadam road, have demonstrated that such surfaces constructed with suitable tar and oil products are efficient under reasonably heavy traffic, provided the patrol system of maintenance is followed. If such a system had not been in use during the past year when from 28 traffic counts an average of 135 motor drays, 816 motor pleasure vehicles, and 61 horse drawn vehicles per day passed over the road, it would from all indications have been completely destroyed.

Bituminous Macadam Under Truck Traffic

With regard to the efficiency of bituminous macadam under heavy motor truck traffic, there are a number of points to be considered. In general, bituminous macadam has not been thought to be efficient for such traffic but, on the other hand, it has almost invariably been placed upon a broken stone or gravel base. Results obtained in the city of Alexandria, which have previously been mentioned, indicate that if properly constructed and laid upon a concrete base the bituminous macadam may prove quite satisfactory.

Aside from character of foundation, it is believed that sufficient attention has not in general been paid to the important details of bituminous macadam construction so as to obtain best results. Too frequently the coarse stone is not sufficiently compacted before the first application of bituminous material is made and later uniform compaction is extremely difficult, if not impossible to secure. Rutting the road with certain types of distributors just prior to application of material is a common cause of lack of uniformity in compaction, and a strong tendency to distribute faster than the road can be satisfactorily compacted and finished by a single roller is another. Best results from this type of road which have come under the writer's notice have been secured by the hand pouring method, although this method is considered antiquated by many engineers. Where the first application upon the thoroughly compacted coarse stone is made diagonally across the enter line of the road and the second pouring or seal coat is made in a direction diagonally across the first, with proper attention to uniformity of distribution it is possible to secure a very excellent pavement, as has been repeatedly demonstrated by E. C. Dunn, City Engineer of Alexandria, Va.

Bituminous Concrete, Sheet Asphalt and Asphalt Block

The efficiency of bituminous concrete, sheet asphalt and asphalt block pavements under city traffic is so well understood as to require little comment in this paper. If laid upon suitable concrete foundations there is no reason to suppose that the results given by these pavements in city construction will not be duplicated on county and state highways subjected to heavy motor truck traffic. If the foundation is inadequate to support the load, the pavement is bound to fail, but, as previously pointed out, failure cannot then be considered a measure of efficiency of the pavement proper.

Materials of Construction

With regard to materials of construction a few comments may not be out of place, as the efficiency of a bituminous surface or bituminous pavement depends not only upon its method of construction but of what materials it is composed.

In general, the author's observation and experience has been that the most efficient bituminous carpets are constructed with the heaviest grade of bituminous material which it is possible to apply and make adhere uniformly to the road surface. For cold surface treatment this will demand either a cut-back asphalt, a heavy asphaltic oil with specific viscosity of 80 to 120 at 25°C. containing an appreciable amount of volatile material that will evaporate after application and leave prac-

tically an asphalt mat residue, or the most viscous refined tar product that can be applied cold. For the latter a specific viscosity as high as 25 to 35 at 40°C. should be used if climatic conditions will permit. While on old macadam roads it is advisable to keep the thickness of carpet under ½ in. on certain types of soft gravel it may be of greater thickness provided a hard and tough coarse aggregate cover of sufficient size to force into the old gravel surface by rolling is used. For clay-gravel or sand-clay-gravel roads north of the frost line it is believed that for maintenance under heavy truck traffic light superficial treatment with bituminous materials applied cold will prove more efficient than the construction of a bituminous carpet although neither will be adequate to carry the road through winter.

With regard to bituminous macadam and coarse aggregate bituminous concrete, there is little to suggest in connection with the grades of bituminous materials originally used. It is believed however that even in the northern United States the use of an asphalt cement softer than 120 penetration or a refined tar of less than 120 seconds float test at 50°C. for bituminous macadam is inadvisable if modern heavy motor traffic is to be sustained. It is also believed that more attention should be given to specifying and securing a uniform size, and grading within reasonable limits, of coarse stone for bituminous macadam in order to promote uniformity in the penetration of the bituminous material as it is applied and to produce a surface that will wear as uniformly as possible. Such specifications should be based upon tests made with laboratory screens and should at least cover the permissible percentage retained on the maximum and passing the minimum diameter of screens selected, as well as the percentage limits required to pass or be retained upon an intermediate screen.

In connction with sheet asphalt and the fine aggregate bituminous concrete the tendency to use harder grades of asphalt cement than heretofore may prove advisable for very heavy traffic conditions. It is quite possible, however, that better results may be secured by a reduction in the compacted thickness of such pavements with a corresponding increase in thickness of binder course where one is commonly used. For fine aggregate bituminous concretes which are commonly laid without a binder course, the introduction of such a course not less than 1½ ins. thick may prove advisable with a reduction in the thickness of wearing course to not more than 1½ ins. Provided the binder course is properly constructed such practice should tend to produce a pavement less susceptible to displacement under heavy motor truck traffic. In any event it is believed that even more attention should be paid to aggregate grading than heretofore in order to produce most satisfactory results.

The resistance to displacement of compacted bituminous aggregates, containing particles from ½ in. in diameter down and consisting largely of sand, is mainly dependent upon grading of the mineral aggregate and hardness of the bituminous cement. When, however, the particles become very small and possess absorptive or colloidal properties neither grading nor consistency of the cementing medium are such important considerations. Very large surface contact and high frictional resistance then become the prime factors. Thus, a fine mastic composed of limestone dust or clay and a very soft asphalt cement may exhibit even greater resistance to displacement than a graded sand aggregate mixed with a much harder asphalt cement. The former type is exemplified by certain finely pulverized bituminous limestones. Use of the latter has but recently passed the experimental stage. It is quite possible, however, that future developments will establish such extremely fine bituminous aggregate as being highly efficient under heavy motor truck traffic for both the sheet and block type of construction.

The foregoing paper was presented at the 16th Annual Convention of the American Road Builders Association, Feb. 25, 1919.

U. S. Department of Labor Creates Division of Public Works and Construction Development

A new division has been created in the Department of Labor for the purpose of interesting the nation in public works and private construction. Secretary Wilson announces that the new service will gather and distribute information that will enable private initiative to make the transition from a war to a peace basis without serious interruption, due to lack of data on which business judgment must depend.

A survey of business conditions will be made with a view to learning how labor and capital may be profitably employed during the critical period when factories are being made over for peace production and markets are being canvassed for future outputs.

The division which will carry on this work is now being organized by F. T. Miller, the publisher of construction periodicals, as a section of the Department's Information and Education Service, of which Roger W. Babson is chief. The new organization is called the Division of Public Works and Construction Development, and occupies the building at 16 Jackson Place, Washington, D. C.

To Secure Data

The particular objective of the bureau's research will be to secure data for the use of the construction industry, but the material to be collected will be so varied that the information will be of value to industry generally. The facts made available will be of help to any community or investor in determining whether it is advisable to undertake public or private building at present. When circumstances unfavorable to construction are discovered an attempt may be made to correct them, but there will be no stimulation of economically unsound enterprise. The finding of the bureau will be given the widest publicity.

The pivotal nature of the building industry in economic reconstruction and the general purpose of the work of this division are expressed in Secretary Wilson's statement:

Secretary Wilson's Statement

"Building construction will help to provide employment for returning soldiers and for workmen dismissed from war industries. One of the largest sources of prospective employment is the building trade and its allied factory industries.

"In the case of private construction, a resumption of activity will also lessen the congestion of population, improve conditions affecting the public health and convert inactive property into active property—which supplies the means that enable communities to support the functions of governments.

"During the war the nation practically concentrated all its efforts on the production of goods for immediate consumption —war materials, food, clothes. The failure to produce the normal quota of goods for future consumption has made these scarce and highpriced, and as they are essential to further production they affect the cost of production and, consequently, the cost of living. Chief among such goods are building and other real estate improvements, including public works, such as roads, bridges, etc. The scarcity of buildings, for example, creates high rents.

The inquiry will be under the direction of business men of wide practical experience who are serving without pay. The actual investigation will be conducted by a group of economists and special agents supplied by the Department of Labor and other Government departments or lent by universities. The field will include the cost and supply of building materials, the amount of labor available and its cost, the values of land, prevailing rents, the supply of capital, the amount of construction held up by the war and the demand for building in all parts of the country.

Under the supervision of the economics section, five other sections will prepare information for publication by the means of the press, public speakers, posters and the mediums of organized labor.

Rigid Paving Inspection Needed to Cure the "Poor Grouting" Evil

By Harlan H. Edwards, Highway Engineer, Highway Laboratory, University of Illinois. Urbana, Ill.

With the approach of an era in highway construction unequalled in magnitude by anything in the past, it behooves those in direct charge of the various projects to take particular pains in the selection of their personnel so that first class workmanship may be assured at all times. This vigilance should be exercised especially in the construction of all grouted block pavements, for much good material and work has been ruined by a little carelessness now and then. It is upon the excellence of the grouting operations that the life of pavements often depends, and any poor work is bound to appear sooner or later.

In most specifications it is provided that all sand for grout must pass a No. 12 or No. 16 screen, yet on many jobs such sand is the exception rather than the rule. With some anything from ¼ in. down goes—with others, ⅛ in. material is satisfactory, yet unless extreme care is taken imperfect filling is bound to occur. The mixture is often made so stiff that it just bridges or plasters over the joints—or made so thin that a heap of separated sand collects below the machine, only to be brushed over the tops of the joints by some careless laborer. Often the first application only fills the joints in part, while the second is so stiff that it merely plasters over the top quarter-inch or so.

At any rate, the pressure of expansion of the pavement is concentrated on a small area at the top of the brick instead of being uniformly distributed over the entire area of the joint. The result we have all seen—the tops of the brick shattered and a rut or hole started. Many laymen place the blame on defective material, while the facts show that it is defective workmanship instead.

The County Highway Engineer-Manager

By E. E. Sours, Engineer, Mecosta County Highway Commission, Big Rapids, Mich.

Many of the larger counties of Michigan have realized the value of a county highway engineer in the directing of their road building. Gradually some of the less wealthy counties, through the example set by the more populous counties, and through other influences, have hired highway engineers, said Mr. Sours, in addressing the Michigan Engineering Society.

At present there are 31 counties in Michigan employing county engineers on a salary. In general, as the engineers have gained the confidence of their commissions as to their ability to manage affairs, this work and authority have been gradually delegated to them.

The road funds of the county are spent on recommendation of the county engineer. It is a common criticism that public money is not spent wisely. In other words, it is charged, and too often justly, that those intrusted with the expenditure of public money do not get as great results, dollar for dollar, as do private enterprises under the same conditions. If the county engineer cannot do better work at less cost than the untrained man, the position of county engineer cannot be justified. It is up to the road engineer to produce results.

Technically, the work of the road engineer is the construction and maintenance of the county roads. How this can best be accomplished must be decided by the organization in each county. It might be well to mention in general some of the essential points which must be observed, if the greatest efficiency is to be secured.

Points to Observe

To begin with, there must be entire harmony between the engineer and his commission. Too often the engineer makes the mistake of assuming a professional superiority over his associates, looking at all problems from a technical standpoint. The other fellow's viewpoint is always worth consideration, even if it is not based on mathematical hypotheses or engi-

VIEWS ILLUSTRATING SEQUENCE OF OPERATIONS IN RECOMMENDED METHOD OF GROUTING A SEMI-MONOLITHIC BRICK ROAD.

(1) After the Brick are Laid and Rolled to a Smooth Regular Surface, and (2) Before Grouting, the Brick Surface is Thoroughly Wet Down, Cleaning the Brick and Moistening the Cement-Sand Bed. (3) The First Application of Grout is then made, Using Sand all of which will Pass a No. 12 Screen. This Grout is mixed to the Consistency of Ordinary Paint and Fills the Joints Completely. (4) After Settlement has taken Place, and Before the Grout has obtained its Initial Set, (5) a Second Application of Grout is made, this Time Somewhat Thicker than Before, but Using Always the Fine Sand which is more Easily Kept in Suspension. (6) This Time all the Joints are Filled and a Very Small Amount is left on the Surface to Provide for Future Settlement, if any occurs. This is now Allowed to Stand until the Initial Set is taking place at which Time (7) the Surface is gone over finally with a Squeegee, Moistening the Surface where Necessary with the Sprinkling Can and Cleaning the Grout off Flush with the Surface of the Brick. (8) This Assures **Completely Filled** Joints and a Smooth Pavement which is Cleaned by every Rain.

neering principles. There is always something to be learned; when an engineer ceases to be a student he is retrogressing. Use tact with your commission, use tact with your foreman, use tact with the public. The best engineering education will avail little if one lacks tact and good judgment.

Some definite system must be followed. The work must be planned so that there are few mistakes and little lost motion.

Good judgment must be used in selecting subordinates. No matter how well plans are laid, if the ones to whom is intrusted the carrying out of the plans are lazy, careless or incompetent, the efficiency of the system is impaired. Every principal is responsible for the actions of his agents. Managers and engineers cannot shift their responsibilities. It is therefore up to the engineer to select the best material available for helpers. Thousands of dollars have been squandered in Michigan on roads by incompetent foremen, because they could be hired cheaply. Money is well invested in a good foreman, while a poor foreman is expensive at any price.

Outside the County

One may say that a county engineer's responsibility ends at the boundary of the county. But does it? The wide-awake, loyal engineer is larger than the county. That time is past when a local community is sufficient unto itself. The trunk line roads of the state are the main arteries of traffic, and are fed by the county system, and these again by the feeders in the township, so that the whole is a comprehensive system of highways, serving every community in the state.

Yet while the counties and townships both are working on the same system, they often work at cross-purposes instead of working hand in hand, and with the state, to complete this system. Local jealousies often defeat the interest of a community at large. The county and township organizations are often widely separated and fail to co-operate, often when it would be a mutual benefit to do so. Probably due to the old method of building township roads, the township organizations sometimes are inclined to resent what they choose to term "interference in their local affairs by state and county officials."

To the wide-awake engineer the law providing for the survey by county engineer of township roads may be made a means of making a closer relation between township, county and state. The county engineer is one of the important connecting links between the township and the state. A township commissioner is not unmindful of a little assistance from the engineer; competent advice, tactfully given, will reap a harvest of better roads and better bridges.

A Co-operative Plan

In this connection may be mentioned a co-operative plan which has been adopted by Mecosta county. As it is a pioneer move along this line it is worthy of consideration. It is not to be presumed that the authors anticipated all of its effects.

Briefly, the plan is as follows:

1. Any township, city, village or individual desiring to build a section of road on the county system makes application to the county road commissioners for a survey and estimate of cost of construction of the parcel of road.

2. The county engineer makes the survey and estimate and submits it to the applicant.

3. Such municipalities or individual electing to construct such road may do so under the following conditions: From the engineer's estimate of cost the estimated state reward is deducted. The township is paid 50 per cent. of the balance and the state reward.

The first payment is 40 per cent. of the engineer's estimated cost of building grade, which includes the culverts, and is paid when the grade is completed and accepted by the engineer.

The second payment of 40 per cent. of the engineer's estimated cost of placing the first coat of gravel is paid upon the acceptance by the engineer of the first coat of gravel.

Final payment is made of the balance due on the road, together with the state reward, when the road has been accepted by the State Highway Department.

If the one proposing to build the road is satisfied with the estimate he files a request with the board to that effect. A contract is then entered into between the contractor and the Board of County Road Commissioners. So far this plan is a source of satisfaction to its promoters. There has been application for survey and estimate of nearly every mile of unimproved road on the county road system.

Advantages of the Plan

This plan, while its main object is the early completion of the county road system without the necessity of a bond issue, at a minimum cost to the public, has more far-reaching effects from the standpoint of the engineer.

It brings the township and county road organizations in closer touch with one another; it admits of a closer supervision of the township roads by the county engineer, and tends to raise the standard of efficiency of the township commissioners.

Assuming that all of the townships accept the co-operative plan of building county roads, the township commissioners practically become county employes under the direct supervision of the county engineer. The commissioners will come to depend on the assistance of the engineer, thereby extending the engineer's influence over the construction of township roads. The benefit of this influence can be no better illustrated than in the case of bridges and culverts.

The commissioner builds the culverts on the county road, necessarily under contract, according to standard culvert plans of the State Highway Department. The wide-awake commissioner appreciates the better results secured under the instruction of the county engineer and uses his education to advantage in his later work in the townships. The county engineer has an opportunity through these commissioners to carry on a campaign against poor concrete and drainage work. This practice of building poor culverts, often with insufficient capacity to accommodate the drainage areas, necessitates their rebuilding within a very few years. It is not only a detriment to the roads, but is an unnecessary bill of expense, thousands of dollars being expended each year in repairing washouts and rebuilding culverts.

While the engineer may not have enough time at his disposal to supervise closely the building of culverts in the township, the fact that he can refer the township authorities to standard plans, and can give the workmen some instruction in the building of foundations and the handling of concrete, is bound to produce better results, especially if he has improved every opportunity to inspire in township officials a confidence in his ability and to create a demand for his service through a desire to be helpful to the local road builders.

Ordinarily one township commissioner is not interested in what the commissioners in the neighboring townships are doing. Under the co-operative plan all commissioners, being employes of the county and working to an estimate, are continually measuring their efficiency by the work of their fellow-commissioners. And, further, interested individuals in a township are comparing the work of their commissioner with the work of the commissioner of neighboring townships.

The effect of these comparisons will tend to make the qualification of a road builder the controlling factor in the selection of the next commissioner, which has not always been true in the past.

Not the least of a county engineer's duties, speaking in a broad sense, is the education of the road men of his county.

Preventing the Opening of New Pavements

One of the most aggravating circumstances in connection with paving of city streets is that soon after the street has been well paved and the residents and property owners have begun to take personal pride in their new improvement, the

pavement is cut up to allow the placing of a pipe line or service connection to some new residence or store building. Progressive communities have grappled with this problem for many years but largely in vain. It has almost come to be taken for granted that a new pavement must be cut up soon after it has been finished, to allow these individual house connections to be made that could just as well have been placed before the pavement was laid, if the prospective builders had only given thought to it.

If a restriction were placed on this indiscriminate cutting up of new pavements by city authorities, this would undoubtedly have a restraining effect on these occurrences. It would cause prospective builders to lay their plans far enough in

-WARNING-
THIS STREET WILL BE PAVED -
All Underground Structures Gas and
Water Pipes etc. Must be put in at once
After Completion no permit to Cut
will be granted for Five Years.
HARRY L. DAVIS, MAYOR.

SIGN USED IN CLEVELAND, OHIO, TO WARN PUBLIC THAT EARLY CUTTING OF NEW PAVEMENT WILL NOT BE TOLERATED.

advance of such paving improvement to permit it being done before the pavement is placed. It would be an incentive to real estate owners to provide service connections at each one of their vacant lots in advance of pavement construction.

Cleveland Method

Cleveland, Ohio, has adopted this solution of this problem. Some time previous to the commencement of a paving improvement, signs are posted conspicuously along the street, giving notice of this work and requiring all underground connections to be placed before the paving is done. Thereafter the pavement must not be cut for this purpose for a period of five years.

Herewith is an illustration of one of their warning signs which clearly indicates their policy in this regard. This is a progressive development on the part of city officials to protect their pavements against the lack of forethought on the part of builders.

Present Status of Brick Pavements Constructed with Sand Cushions, Cement Mortar Beds and Green Concrete Foundation

By Maj. Wm. M. Acheson, State Highway Department, Syracuse, N. Y.

Brick pavement construction since 1915 has been subject to far greater changes in design than any other pavement. These changes, through a more rational use of the same amount of material, have tended to greater strength and durability. In this paper it is the intention to describe the three different types of pavement, or I might say the old and the new methods, and point out the advantages and disadvantages of each.

Foundation Course

The foundation course is usually made of cement concrete and in general a 1:2½:5 and 1:3:6 mixture is specified, the thickness depending largely upon the character of the subsoil and the amount of the traffic. While the cement concrete foundation predominates in brick pavement the construction of many miles has been laid on foundations of compact sand, gravel and broken stone. Engineers will agree with me in the absolute necessity and economy of concrete as a foundation for brick and all types of block wearing surface, together with mixed types of bituminous pavements. In fact, to my mind, the time is here when highway engineers are called upon to design rigid types of construction to meet the demand of modern traffic, which means the development of heavy motor driven traffic. Engineers are now giving special attention to the different parts of a pavement in order to meet existing conditions. Metal reinforcements is sometimes specified to be imbedded in the concrete foundation over soft places and recently dug trenches. By this it is hoped to prevent the cracking which in the majority of cases comes from the condition of the subsoil through the base to the surface of the pavement. Experience has shown that an evenly built foundation which conforms to the finished cross-section of the road, will result in a uniform thickness of sand cushion and a smooth wearing surface. In this pavement as in all other pavements the key to the whole situation is the condition of the subsoil and the foundation, and in this phase too great care cannot be exercised from the design or construction standpoint.

Sand Cushion

Brick pavements with a sand cushion or a bed course of plain sand have been built since the first brick pavement constructed in 1870 and represent at the present time by far the larger percentage of the three types. The thickness of the sand cushion called for in the older specifications in constructing this type of pavement has been considerably greater than advocated by most engineers at the present time. The theory advanced in behalf of the sand cushion is that it serves the double purpose of providing a uniform bearing for the wearing surface and supplies resiliency under traffic.

With this in mind specifications called for a sand bed not less than 2 ins. in thickness many of which were not given the proper care in constructing and were formed by screeding out the full thickness at one time without necessary consolidation by hand rolling. This was responsible for failures in the brick wearing surface which engineers traced directly to the non-uniformity of the sand bed. This was endeavored to be corrected in later specifications by calling for a sand cushion of not over 1 in. in thickness, together with requirements as to its gradation by sieve analysis and the amount of loam permissible in the sand used.

New York State specifications for the bed sand required a sand of which 100% passes a No. 6 sieve and not over 90% through a No. 20 sieve. "An excessively fine sand will not be accepted in this class. Sand may be rejected if it contains more than 15% of loam and silt," which amount was deemed advisable for proper compacting.

Present day specifications describe carefully the manner of forming or building up the sand bed by screeding it in layers and rolling the layers in order to form as nearly as possible a uniform bearing for the wearing surface.

Notwithstanding all the precautions and refinements of the later specifications where a sand bed is used, it has been shown that the defects were not overcome in the wearing surface, this being due to the fact that it is impossible properly to compact a sand bed varying in moisture content and thickness. Also a wet sand cushion when dried out will shrink and leave hollow spaces, consequently defeating its function of providing a firm and uniform bearing at all times for the wearing surface. Another defect of the sand cushion is that it works up into the joints of the brick and prevents the joint filler to penetrate thoroughly and bond properly the wearing

surface. In the repairing of many of our brick roads I have seen defects in the surface caused by the sand cushion coming up into the pavement at least 2½ ins.

Wearing Surface

The wearing surface of the pavement is composed of vitrified paving brick joined together with a filler. Smaller bricks were used in the early manufacture for brick pavements and without lugs. Later in order to obtain a uniform width of joint to take the filler the brick were made with lugs by repressing. The standard paving brick of today is 3½ ins. in width by 8½ ins. in length by 4 ins. in depth, laying 40 brick to the square yard. These brick are larger than the first brick manufactured.

Wire-Cut Lug Brick

The wire-cut lug brick came into vogue in 1910, the first wire-cut lug bricks being used by the New York State Commission of Highways in the construction of the Williamsville road near Buffalo. These brick have steadily increased in favor with paving engineers and are now universally called for. The experience of New York State with the wire-cut lug brick has been that it possesses uniform lugs and fiber sides, due to the method of manufacture. The fiber sides which are always obtained in a wire-cut brick give a greater bond strength at all times, while the uniform lugs insure a thorough and even penetration of the filler, and from a construction standpoint provide parallel joints, which means better construction. The square edge of a wire-cut brick in addition means a flush joint, which produces at all times a smooth wearing surface and one which will not cobble under traffic.

Joint Fillers

Two classes of joint filler are used to bond the brick units together, the cement grout filler and the bituminous filler. My experience and observation are that the results from the cement grout filler are superior and more durable than the soft filler and one which is absolutely necessary in modern semi-monolithic and monolithic types of construction. If soft filler is used the old sand bed is more likely to be the design. New York State specifications for cement grout filler allow the use of grout made of 1 part cement and 2 parts of grout sand, if machine mixed, and a grout made of 1 part Portland cement and 1 part grout sand if hand mixed. In general the specifications of today call for a grout made of 1 part cement to 1½ parts of sand. Machine mixed grout is, in the opinion of most paving engineers of today, far superior to hand mixed and at the same time is more economical in manipulating. Paving engineers recognize the necessity and importance of the grout filler and are taking every precaution in the selection of the materials and their application.

Brick Pavements With Cement Sand Beds

Experience and observation have demonstrated that many failures in the wearing surface are due to the sand cushion, which engineers have endeavored to combat. The solution of this factor has been the development of the cement sand bed which provided a non-shrinking, rigid super-foundation, thus making the first step toward a brick monolithic type of construction. Brick pavements constructed with a cement sand bed are commonly known as semi-monolithic construction and from this type developed the true brick monolithic construction which is now being used by highway engineers. The semi-monolithic type is the same as other brick pavements constructed with sand cushions, except that a mixture of sand and cement mixed in general 1 part Portland cement to 3 parts sand is substituted for the sand cushion. It is the practice to mix dry these materials thoroughly by machine in the proportions specified. The mixture when spread out should be screeded with a template cut to the required contour of the finished pavement. Care should be taken to get uniformity, but hand rolling is not deemed advisable as it has been learned that a rolled cement bed does not insure a smooth wearing surface due to its great density. With an unrolled surface the brick as laid is always bedded in the cement sand superfoundation. The thickness advocated in general is a minimum of ¾ in. and a maximum of 1 in. It is my practice to wet the cement sand bed with a sprinkling can just ahead of laying the brick. Immediately preceding the grouting the brick surface should be thoroughly wet.

Semi-Monolithic Construction

With present methods the semi-monolithic type of construction is better adapted to wide street construction than the monolithic. All precautions should be taken in the mixing and the application of the grout filler.

The advantages of semi-monolithic construction are that it overcomes the defects of the sand cushion by insuring rigid construction in that it practically unites the wearing surface with the concrete foundation. The cement sand cushion at all times provides a perfect bond for the full depth of the brick. This type eliminates the shrinking which is common in a sand cushion and at the same time eliminates the hollow or rumbling noise which is common with the sand cushion type of construction. It gives a more economic and scientific design in that it provides a stronger slab with the same material.

Brick pavements with cement sand beds were built in Baltimore as early as 1906 and adopted as their type of construction in 1915. The cement sand bed was used in Jacksonville in 1910 and also in connection with the paving of the ramps of the Pennsylvania Railroad terminal in New York in 1910. It has been demonstrated that shallow vitrified brick will stand up under heavy truck conditions when laid upon a cement sand bed. In this case fire clay brick 2¼ ins. in depth were used. This work in the Pennsylvania terminal demonstrates that in many places a block of less depth than the standard block can be economically used, and in fact, in the city of Syracuse an experiment was made by which a 3½ in. block was laid on a cement sand cushion with railroad tracks in the center on a street entering the city and satisfactory results have been obtained and I have in mind that the next pavement that we lay of this kind a 3 in. brick will be specified.

Brick Pavements With Green Concrete Foundations

This type of construction is commonly known as the monolithic type and is better adapted for highway construction up to say 24 ft. in width or where a templet may be used to shape the entire width of road at one time. It was first used in highway construction near Paris, Illinois. Proper consistency of the concrete foundation is essential for this type of construction. Care should be used in the proper spading and distributing of the concrete to prevent waves in the finished pavement due to possible difference in density. The concrete foundation is spread usually ½ in. high and formed by using a tamping templet which brings to the top a smooth mortar surface on which to bed the brick.

A Power Templet

For this purpose there has been developed a mechanical templet which consists of a gasoline engine mounted on a cross frame with wheels, which is carried on the side forms. This power templet performs the double purpose of tamping and smoothing the concrete and in addition compresses it to better density. This templet moves at the rate of 4 ft. a minute and can be adjusted to different widths. The laying of the brick wearing surface should follow closely on the concrete foundation and should be inspected, culled and rolled before the cement has its initial set. For rolling the wearing surface a hand roller is advocated about 30 ins. long, 24 ins. in diameter, weighing from 600 to 900 lbs. The rolling should follow immediately after the inspection so that the grout filler may be applied at once to secure the necessary bond with concrete foundation.

In this connection the so-called wire-cut lug brick is of special value in that it develops the full strength of the slab by reason of its superior side bond, due to its fiber sides, and

assures penetration of the bonding material to all parts of the joints due to its uniform lugs.

Handling Grout Filler

The mixing and placing of the grout filler is of the utmost importance for this type of construction as in the construction of brick pavements of the other types and the same precautions must be taken in the selection of the materials and their application.

All the advantages claimed for the semi-monolithic type of construction will hold for the brick pavements constructed on green concrete foundations to which may be mentioned the added increment of slab strength due to the more perfect bond of the wearing surface and the concrete foundation. This type also eliminates the use of edges in highway construction, which reduces the cost. The use of semi-monolithic and monolithic types have tended to develop the use of paving brick of less thickness which will result in economies, one of the most important being the saving in transportation charges. There should also be an economy in the first cost together with a saving in actual manipulation.

Sand Cushion is Obsolete

In my opinion the day of the sand cushion on rigid foundation is ended and the satisfactory type is a cement sand cushion for village and city streets, and that brick pavements for highways should be constructed on a green concrete foundation.

In closing I wish to emphasize the paramount importance of proper design of highways to take care of modern traffic. To my mind a rigid foundation is absolutely necessary on main trunk lines and where truck traffic predominates or may develop in the near future. The use of motor trucks for commercial purposes has grown tremendously and it is our duty to design highways which will be able to stand their loads up to reasonable limits and with reasonable maintenance charges.

The foregoing paper was presented at the 16th Annual Convention of the American Road Builders' Association, Feb. 25, 1919.

Some Points to Observe in the Construction of Concrete Roads

By William W. Cox, Deputy State Highway Commissioner, Lansing, Mich.

The construction of a concrete road appears very simple to the average person who has not made a thorough study and investigation into the essential details entering into the operation from start to finish. Adequate drainage, preparation of sub-grade, selection of materials, workmanship and protection, all have important bearing upon the desired results of obtaining a first-class concrete road.

Adequate Drainage

The all too common practice of placing concrete on a poorly drained grade cannot be condemned too strongly. Simply because of the bearing power or rigidity of concrete many are inclined to think that the presence of water in the subgrade does no particular harm. A concrete road so placed may show up very well for a short time, but sooner or later the action of frost and the result of heavily loaded vehicles will cause the concrete to crack badly and thus, eventually, result in complete failure of the road. It is, therefore, necessary first to provide good drainage so that the water level in the subgrade is at least 2 ft. below the concrete. All cracks or breaks, however, are not caused by inadequate drainage. Uneven settlement of the subgrade seems to be cause of the majority of the cracks which develop within a short time after the road is completed. It has been observed that where concrete roads have been built on new rights of way, where the entire grade was made new, very seldom any longitudinal cracks develop. Likewise, excellent results have been obtained in cases where the subgrade has been graded one year and the concrete placed the next. Also, longitudinal cracks in cuts are at a minimum where proper drainage has been provided. These results are conclusive proof that details of drainage and the detail in construction of the subgrade should not be omitted.

Preparation of Subgrade

It is well, likewise, that great care be exercised in the preparation of the subgrade so as to eliminate uneven settlement. To do this where narrow fills or turnpikes exist, they should be scarified, plowed and completely leveled and rolled to the full width of the grade before additional grading is done. The earth then should be placed over the full width, in layers not to exceed 1 ft. in thickness, each layer being thoroughly leveled and rolled. Whenever possible, if it does not seriously inconvenience the traveling public, it is recommended that the grading be done far in advance of the placing of concrete. Where light sand is encountered, watering heavily seems to be about the only method of securing satisfactory settlement; but if only spots of sand are found, it is best that the sand be removed and replaced with surrounding soil. In the final preparation of the subgrade prior to the placing of concrete or aggregate, care should be taken to see that it is true to form and to the proper elevations and that all loose earth is sprinkled and rolled. The placing of concrete or aggregate on loose earth or dust cannot be too strongly advised against.

Coarse Aggregate

The coarse aggregate should be either clean gravel or crushed stone.

Gravel should be composed of hard, clean, well graded pebbles, ranging in size from ¼ to 2 ins. Clay lumps, soft red sandstone or cemented pebbles cause surface defects, and therefore should be rejected. Properly graded gravel should be approximately as follows:

Passing a 2-in. screen	100%
Retained on a 1-in. screen, not less than	25%
Passing a 1-in. screen, not less than	25%
Retained on a ¼-in. screen, not less than	95%

If it is found impracticable to obtain such a grading of gravel, and another grading is used, it should be an even grade in respect to keeping the voids constant.

Crushed stone should be of good angular fracture even run in hardness, and when tested by the standard method should show a toughness of at least 8 and a French co-efficient of wear of not less than 10. Some of our limestone deposits, if handled with care, can be used for coarse aggregate. Crushed cobbles or field stone, when properly sorted, can in many localities be used to distinct advantage. Stone which, when crushed, spalls or pulverizes considerably, of course, should be sorted out.

In the selection of both crushed stone and gravel, coated or dirty material should be rejected, even though the percentage of clay or silt is comparatively small. The range in size, even run and percentage of voids for crushed stone, should be about the same as for gravel.

Fine Aggregate

Fine aggregate should be practically clean of silt, clay or loam and graded approximately as follows:

Passing ¼-in. screen	100%
Retained on No. 20 sieve, not more than	60%
Retained on No. 20 sieve, not less than	60%
Passing No. 50 sieve, not more than	20%

A coarser sand is recommended when used with crushed stone. Cement should meet the requirements of the standard specifications for Portland cement adopted by the American Society for Testing Materials in 1916.

Water should be free from oil, acid, alkali or vegetable matter and fairly free from clay or silt.

The batch mixer is considered the standard and should be so equipped that the number of revolutions for a given length of time can be easly obtained.

The forms should have a straight surface and should be set to a true grade and so thoroughly staked in place that no move-

ment can take place when concreting and finishing is being done.

Mixing and Placing Concrete

The amount of labor used in the laying of the concrete should be such that every detailed operation can be completed at the proper time and so that the whole is a steady progression. The more nearly the proportions of coarse and fine aggregates and the proportions of cement and the consistency of the batches can be made uniform, the more certain that the concrete when seasoned will give an even resistance to wear. The amount of water used in the mix should be just enough to insure that the mixer will completely discharge its batch to the conveyor. Concrete containing the proper amount of water requires considerable shoveling in place. Alternate dry and very wet patches will cause unequal shrinkage in the body of the concrete, and hence a wavy and unsatisfactory surface. More depressions are caused in the surface by the use of too much water than in any other way.

The subgrade should be well saturated before placing the concrete so as to avoid losing too much moisture before the finishing is complete.

Finishing Concrete

The finishing of the concrete, after being shoveled in place, should proceed immediately. It should be surface struck by a rigid template a few times over and then allowed to stand a few minutes until the surplus water comes to the top. The use of a roller of the Macon type has proven a great help in the finishing of the concrete surface. By its use, the excess water and air are brought to the surface, hence denser concrete is the result. Another great advantage in using the roller is that the ridges and depressions made by the template are entirely removed by rolling a few times. It should be operated, however, with care and judgment so as not to roll out the crown or make heavy depressions in the surface next to the forms. Although the split roller is used in bringing the concrete to the same height on both sides of the joint, nevertheless a split float and template should be used also. The rollers which seem to be the most satisfactory are about 15 in. in diameter, 5 ft. long and weigh about 75 lbs.

Joints

Cracks and joints are admitted to be the weak points of a well constructed concrete road, hence great care should be used in placing the joint and finishing the concrete adjacent to it. After a joint is placed and the striking of the concrete progresses towards the joint, there is usually an excess of concrete which has to be removed, hence considerable puddling and working of the concrete is necessary in order to have the surface true to cross-section. On the opposite side of the joint or at the beginning of the section, the striking of the concrete does not cause very much puddling, hence the shrinkage is considerably more and the result is a high and low side at the joint. It is, therefore, recommended that striking the concrete should proceed toward the joint enough so as to give about the same puddling effect on both sides. The joint should then be finished with a split float and template so as to finish both sides at the same height.

Because of the trouble encountered in finishing the open joint many authorities are now advocatitng the concealed joint which is placed so that the top of the joint is not more than ¼ in. below the surface. When concealed joints are used they should be held in place as near the surface as possible so that the joint filler will be forced out when the concrete seasons and expands.

Belting

After rolling is completed, the surface should be floated with a wooden float or belted to a rough finish. Considerable trouble is often encountered when belting is tried, due to the fact that inexperienced men attempt to belt when the surface is too wet, or attempt to belt too fast. It is rather difficult to describe the exact procedure in belting, or just when to belt, but both can be easily learned by perseverance and observation.

During hot weather or when evaporation is rapid, the surface should be protected by canvas until hard enough to permit sprinkling and covering with earth. Different combinations of aggregates, varying conditions of weather, and different brands of cement, as well as sub-soil conditions seem to cause concrete to behave much differently from other combinations. The mixing, placing and finishing of concrete made from crushed stone and sand are considerably different from those operations when gravel and sand are used.

The use of expansion joints is still a debatable question. The distance between joints varies considerably, but experience seems to indicate that a ½-inch joint every 50 ft. is adequate. Concrete which is laid in the fall seems to expand the following summer more than concrete which is laid during hot weather. Thus the concrete road question is a live and debatable subject.

Notwithstanding all the various points in view, I think we are safe in saying that 75% of failures and unsatisfactory results in concrete roads could be entirely eliminated if the essential details of good practice and construction were thoroughly observed.

The foregoing discussion is from a paper before the Michigan State Good Roads Association.

Some Suggestions on the Proper Construction of Granite Block Pavements

By Albert T. Rhodes, Field Engineer, Granite Paving Block Manufacturers' Association of the U. S., 31 State Street, Boston, Mass.

The production in the Northern granite quarries is entirely different from that in the South, due to the fact that the mass of granite has been constructed by nature in an entirely different manner from that in many of the Southern quarries.

Procedure in Northern Quarries

In the Northern quarries the granite is sub-divided by bed seams and other vertical seams, oftentimes the sheets piled layer after layer one on top of the other. The original mass containing the individual granite block is broken away by a series of small holes drilled for about 3 ins. on a line of fracture on which it is intended the stone to break. In these holes are placed what is known as shims and wedges, or plugs and feathers. Two shims are placed in a hole with a wedge between them—the shims tapering upward and the plugs tapering downward. When they are all in place the wedges are gradually driven down by a sledge hammer, little by little, exerting an enormous pressure upon the rock and finally rending it away from the original mass of stone in the quarry. Then the necessary dimension lines are laid out on the section so separated and the operation continued, after tracing a line with a chisel and hammer to indicate where the fracture of the block is to occur.

The peculiar thing about this tracing of the block is that although it does not cut into the stone to a depth of probably more than ⅛ in., still it seems to be enough to start an invisible fracture which the final break follows in almost every instance in a marvelous manner. The sub-division continues both vertically, and by turning the rock up, horizontally, until on some of the final breaks the stone is so small that by tracing on one side and turning the small cube of stone over, striking directly opposite the tracing with a stone hammer, the block separates finally into two individual blocks or halves. Any slight irregularities are trimmed off by a tool known as a reel, bringing the final product out in clean-cut lines with a variation in general of not over ⅜ in. from a straight line across the block.

Old Hand Method of Producing Granite Blocks Still the Best

It must be understood, naturally, that owing to the fact that granite paving blocks have been in use as a pavement in

this country for a very long period that very few radical changes or improvements in either the manufacture or laying of the material can now be brought about. There are several matters, however, which are of general interest to engineers and commissioners of public works, which are well worthy of consideration in the manufacture of the material itself.

It is understood that if any method could be devised whereby a paving block could be machine-made more quickly than it can be produced by hand, this method would be adopted; but the difficulty in handling the larger size original stone, which is gradually sub-divided in size down to that of the final finished paving block, is such that it does not lend itself readily to being placed in any machine constructed for this purpose. The continual decrease in size and the necessary handling of the product in its course of manufacture makes it extremely difficult to produce any machine which will do this work satisfactorily, consequently, the old hand method of production of granite blocks will probably continue for some time longer, although hope has not been given up that the proper labor saving machine may yet be produced.

When it is realized that the sub-division is made from a large block containing eight standard size paving blocks down to the final finished product of the standard block in 90 seconds, it can well be seen that a skillful mechanic can produce these stones with such readiness and can handle them by hand in their various sizes and shapes from the large rock, containing probably a cubic yard of material, down to the finished block, that it would be difficult to find any machine to handle the proposition much more economically for the reason that there would be considerable manual labor used in shifting the various sizes of blocks and the machine itself into position for cutting.

Procedure in Southern Quarries

In the South, owing to the fact that in many of the quarries the hills are one monolithic conglomerate mass, it is absolutely necessary, in order to separate the stone, that a bed seam should be obtained. This bed seam is created in an interesting manner. A hole is drilled down into the stone about 2 or 2½ in. in diameter. In the bottom of this hole a small charge of powder is exploded. This creates a small chamber and starts a seam extending out around the bottom of the hole. Into this hole a compressed air line from the quarry is introduced by iron pipe, which is plugged around the top and made absolutely tight against any leakage of the air under compression. Men are stationed at various points around the outside of the quarry and the signal is given. The air compressor begins its work—great groanings and wrenchings are heard from under foot, extending further and further away from the original drill hole where the air is introduced, until some one of the watchers on the outside circle observes a crack appearing, when the signal is given that all is over, for immediately upon release of the compression of the air through an outside point, naturally the compression becomes released and no further action can be expected from it. In this way several acres of the stone are raised at a time and the quarrying begins after a prependicular face has been produced, and is continued back until the bed seam runs out to nothing at the edge of the quarry.

It will be noted from the above statements that the production of the granite block is not in any way similar to the production of crushed stone, that no internal fracture or strain ever occurs in the inside of the final finished product, that granite has free lines of cleavage and a grain similar to that of wood, some stones from their nature, being finer of grain, split very freely and cleanly leaving smooth sides with no

VIEWS OF QUARRYING AND CUTTING OF GRANITE PAVING BLOCKS.
Top Row, Left: A Southern Quarry, a Monolithic Mass Without any Seams—Right: Northern Quarry with Bed Seams and Joint Planes. Bottom Row, Left: Cutting Blocks—Right: Breaking out Stock for Blocks.

bunches, other stones from their composition are coarse and show a rough exterior, but their value in either case is there and the traffic eventually wears them down to a smooth top and an easy riding street.

We have in my home city one of the earliest cement grouted granite pavements, in existence over 20 years, which today, so far as any visible wear is concerned, as compared to human life, would be just about ready to begin its kindergarten course. No more than the ordinary roughness has been smoothed from the stones and today its appearance is similar to that of a well troweled monolithic side-walk.

The reason why these same results are not uniformly obtained is because of the lack of proper paving, proper ramming and proper grouting. The municipality often gets 95% of what it pays for but the other 5% through ignorance, carelessness or absolute dishonesty so injures and spoils the 95% received that practically no value is obtained for the money paid.

Hints on Proper Construction

It is absolutely essential that each block be rammed home to a full and solid bearing. This must be done individually, by hand, and the skill and the eye of the rammer enters very materially into the appearance of the finished pavement. It is absolutely impossible to get proper results through any other method than the individual ramming of the stone because there is in each block more or less allowed and allowable variations in depth; and it will be seen that if a roller or any other device of that nature be operated over the pavement, only the deep blocks will be properly bedded home, the shallow ones not receiving the proper compression, the machine riding on the high, deep blocks. Each block showing too much settlement from the ramming should be taken out, not with pinch bars, but with a pair of paving tongs. The use of pinch bars would dislocate and disarrange all the surrounding blocks probably for several courses away. Upon the blocks being removed the necessary amount of bedding material is placed in the space and the block returned and rammed home to a proper bearing.

Pea Stones in Joints Bad Practice

It used to be the custom to use pea stone in the joints of the blocks in order, it was claimed, to steady the block and keep it upright in place. This particular feature has proved to be one of the most deterimental phases of the construction of the pavement in the past. Through ignorance, or carelessness, or dishonesty, the blocks would become filled to too great a depth with the pea stone, a collar of grout would be formed around the block with the entire bottom of the perpendicular joints filled with loose pea stone. The action of travel would tend through its impact from various directions to drive the block down, or sideways, or endways downward. The consequence was that through the pinching of the grout around the top of the block in this manner the top of the block would split loose, the body of the block being driven downward. It would then often be claimed by the person in charge, not familiar with the particular reason for this defect, that the blocks were soft. This idea of the necessity of pea stone in the ramming of the block has been thoroughly exploded, and today no difficulty is experienced in ramming the block dry and then filling the joint with a 1 to 1 grout from top to bottom. There then being no opportunity for a lateral or downward motion, the block being properly grouted and properly rammed, there can be no question that nothing but the impact or abrasion of travel can wear the top of the block off. This wear occurs in a very gradual manner and after a period of from 15 to 20 years the amount of wear on certain of our heavily travelled granite pavements, which have come under my observation, can hardly be measured in fractions of an inch.

Proper Grout Mixture

There has been much discussion in regard to what is the proper mixture for grout, but from an observation of hundreds of cases, and from samples taken up and in the writer's possession, there can be no question but what a 1 to 1 grout most nearly approximates the actual toughness and wear of the granite blocks which it surrounds. I have in my possession samples which have been down for 14 years in which the grout was allowed to cover over the top of the new block when it was laid, and this grout, after 14 years of wear, has only worn enough to show the top of the stone through in several places.

Naturally, the improvement and care in cutting is an advantage over the old style rough block which we used to be familiar with and which no doubt has given us our most vivid recollections in the past as a sample of what good granite paving is *not*. Today the short, closely cut block makes a smooth, durable, easy riding pavement, agreeable to everybody and standing the most severe traffic which we are inflicting on pavements at the present day.

VIEWS ILLUSTRATING THE DURABILITY OF GRANITE PAVING BLOCKS.

Top: Blocks Removed after Fourteen Years' Wear to Permit Replacement of Street Rails Completely Worn Out. Center: Repaving Track Area with Blocks Shown in Top View. Bottom: Blocks laid for Thirty-six Years in Sand Joint and Relaid Five Years ago in 1:1 Cement Grout.

Modern Adaptations of the Material

In addition to the construction of the new pavement from this material, we have today several modern adaptations of the material giving extremely good results.

For the replacement of worn out pavements having a depth of approximately 4 ins., and in which the original concrete base is in good condition and still serviceable, there is being manufactured a type of block 3½ ins. in depth which recommends itself very highly to this type of construction and naturally the durability will be far in excess of any of the other types of pavement to which it succeeds.

The latest type of improved granite block paving which is being introduced because increased truck travel has made a demand for the most permanent type of trunk line highway construction may be briefly described as folows:

On a well compacted sub-grade, a cushion course of at least 1½ ins. after ramming of the pavement, of 1 to 3 dry cement mortar cushion should be placed. This may be slightly sprinkled in order to assist in the settling, and the blocks paved on this cushion course. After the blocks have been rammed the pavement should be sprinkled with water to assist in setting up the cushion course and also to bond more properly the 1 to 1 grouting, which is to follow, to the blocks themselves. This will produce a monolithic pavement from top to bottom, and compare favorably in cost with many of the other types of trunk line highway construction.

For Standardized Blocks

Much may be accomplished in the matter of the producers holding a good stock of material on hand if the engineer can be brought to realize that he gains no particular advantage by sticking to his "pet" size of block. The more the blocks are standardized the more readily will the producer have confidence in the ultimate consumption of any style of blocks which he may produce and hold in stock in his quarries. If the engineer will realize that in general there are schedules of sizes under which the paving cutters operate, under annual signed agreements, and any deviation from these sizes, in the way of special cut block, calls for an increased charge by the cutters as a special cut block, without in any way improving the quality of the work on which it is used, the standardization of sizes to not more than three or four different types will bring about the confidence of the producers in going ahead and making stock sizes, holding them in storage in quantities for immediate shipment, eliminating a great many of the delays which are often occasioned by the quarrymen having to produce sizes wanted after having received the order for the work.

Bituminous Expansion Joint Strip at the Curb

A bituminous expansion joint strip at the curb is coming into general practice performing two duties. It takes care of any lateral expansion across the street and also eliminates any continuance of vibration (if there be any) through the roadway pavement, to and through the curb and sidewalk to adjacent buildings.

Protecting Green Cement Grout

Through the common knowledge of the use of cement it is readily apparent that once the bond is broken between the grout and the granite paving block that no further union can be made to take effect between the stone and the mortar, consequently one of the most vital and essential things which can be instituted in favor and for the protection of the granite block pavement is proper barricading and proper policing. The cement in general takes its initial set in one-half an hour and should it be disturbed after that time the results are disastrous. Normally, also, the street will not be ready for opening to traffic inside of about six days, consequently during this time it is absolutely necessary to barricade the work. Proper barricades should in every case be erected and maintained during this period. Should there be a car track on the street on which the cars are operating, it is naturally almost impossible to protect the pavement to the full extent, unless it is policed by watchmen. All barricades have to be set back far enough from the rail so that the cars may pass and repass without striking them, and the traveling public through carelessness or ignorance often do a very considerable amount of damage by operating the wheels of vehicles outside of the car track area over the strip of freshly laid pavement. We do not believe that if the public really understood and had knowledge of the disastrous effects of their trespass upon the newly laid pavement that they would persist in actions so detrimental to the good results which their municipality will benefit from and a general campaign of education along these lines, even in the public schools, will do much in preserving for the tax payer the great results which he will obtain if the pavement is finally opened to traffic in proper condition.

Use of Mortar Cushion

The use of a mortar cushion, which, in the writer's opinion, should be of a 1 to 3 mix, to give it sufficient stability, is coming into general practice for use instead of the sand cushion under the blocks. This, naturally, is laid dry, sometimes sprinkled a little bit, and always sprinkled with a hose in advance of the grouting of the blocks. Naturally the blocks need to be rammed immediately after the laying, and the ramming kept up very close to the work of paving. The use of this mortar cushion accomplishes several purposes. It makes a more stable cushion if a block is not rammed to a full bearing on the cushion. It eliminates the disagreeable feature of the old sand cushion, where, after the paving was completely grouted often times the vibration of traffic on the top of the pavement would rattle the sand particles out of position in the bed, leaving the improperly rammed block suspended by the grout alone. Naturally, with the incorporation of the cement with the sand the setting of the cement itself holds the particles of sand in place under the block. It also tends to make a monolithic pavement from top to bottom.

Use of Bituminous Mastic Filler

The use of the bituminous mastic filler is more or less in its infancy, although it has been in practice for probably five years, superseding the old pebble and pitch type of joint filler. This construction is really very little known in the country as yet. It is probably more commonly used in New York City, Borough of Manhattan, than in any other district in the United States. It cannot be expected that this particular filler will show the durability of the cement grout filler, but circumstances alter cases, and to accomplish certain results this filler fills a long felt want. By the use of this filler a street may be opened to traffic probably six days earlier than where a cement grout filler is used. In addition to this as the mastic is ready for use immediately upon cooling, any accidental traffic happening to pass over the pavement immediately after it has been grouted would not have the injurious effect that it would upon a cement grouted pavement. Where the finished pavement is subject to many trench openings from time to time after being constructed, it is easier to open the paving if constructed in this manner; and naturally where the traffic is so active as it is in the downtown section of Manhattan, New York City, the saving of six days in the closing of a street means very much to the business conducted on that street.

There is another place where this bituminous mastic filler comes in to great advantage and that is on hillside work—giving the proper toehold for horses.

In general I do not think that the best results are being obtained at present in the matter of the bitumen which is used in this grouting, owing to several reasons. The necessary requirements for this joint filler are as follows: It must, and this is of utmost importance, have the quality of extreme fluidity so that it will flow readily to the bottom of the joints. It must have a high melting point so that it will not readily flow and soften in the summer sun, and should have a low penetration, extreme toughness and strong adhesiveness. Ask a contractor which he prefers to use of the two classes of bitumen and he will tell you he prefers to use one, but he thinks the other makes the best job. The greatest difficulty in this matter, to my mind, is that the tar and asphalt producers are in opposition in this matter. A good paving joint filler could be produced and marketed, made of a combination of the two materials, but neither is content unless the product is composed entirely of his own material.

The American Society for Municipal Improvements Specifications call, in the case of brick, for 40 to 60 per cent of sand and 60 to 40 per cent of bitumen. In the case of their granite block specifications the proportions called for are 35% to 50%

sand. There is no reason why the two should not be alike. I do not find that it is practical, in any event, to mix, without extreme care and fussiness, any mixture containing over 50% sand, nor is it conducive to the proper expediting of the work. The contractor's end of these matters has to be considered and what can be accomplished by energetic mixing in a laboratory is often impractical in the field.

Methods of Contracting for Highway Work During the Reconstruction Period

By John H. Gordon, President New York State Road Builders Association, 25 N. Pearl St., Albany, N. Y.

The generally accepted method of contracting for highway work throughout the United States is upon a lump sum bid, based upon unit prices of estimated quantities, the final settlement to be determined as a result of a final survey showing the actual amount of work done. As a rule the preliminary estimate and the final survey closely approximate, rarely is there any material difference.

This form of contract has its merits and demerits, every form of contract has, everything in the world has. It was found satisfactory in most cases until the war period. The contractors who found themselves with work taken at pre-war prices, had two alternatives, one—to abandon their work at the cost of their business existence, and the other alternative to complete the work at a great loss.

However well disposed a contractor may have been to have supported his own loss, the resources of many made this impossible, and we see in New York State forfeited contracts totaling on road work alone $5,000,000.

Present Prices

And again, we are now at a point where a contractor will be called upon to hazard another guess as to the future. Engineers' estimates are the basis for the appropriation and in a measure regulate prices. It is the custom for engineers to base their estimates upon prices prevailing at the time the estimate is made, subject to subsequent alteration if any material change occurs between the date of the estimate and the date of the letting.

Today, prices have fallen but little from the highest, the matter of unskilled labor—the most important element in road contracting—is certainly undecided. Therefore, the contractor bidding today, if conservative must base his costs and bid upon the high, both in material and labor. Should there be a material decline between the day of the letting and the finishing of the work, the contractor will profit, just as the contractor lost under the conditions of rising prices after the beginning of the war.

Labor Shortage May Come

It may be said that we have little occasion to enter into a discussion of this condition, inasmuch as the probabilities are strongly against further wars, or abnormal conditions produced by these wars, during this generation. But a similar situation, if not so extreme, may arise from other causes, great scarcity of labor being the principal one, and on which neither the contractor nor the state can make an entirely certain deduction.

But these remarks are made simply as an illustration of how extreme conditions may affect this form of contract. This form of contract is definite, the exact amount to be paid for the work specified is known. Should there be occasion to add to or subtract from the work, we have the unit prices to guide us. The terms are known, and there is little ground left for dispute. That it is a form in almost universal use for all kinds of construction is evidence of its merit.

Bonus and Penalty Feature

There are some modifications of this form of contract. One is where the contractor makes an estimate of cost, and agrees to accept a definite fee, usually 10%, the collection of this fee depending upon accuracy of his estimate. Should the cost exceed his estimate, the contractor will lose, up to within 50% of his fee, the amount of this excess. Should the cost be less, the contractor will receive an additional payment of 50% of the saving.

Allowance for Price Fluctuations

It is customary in some forms of lump sum contracts to state the cost price of material and labor used in making the estimate. In this form of contract the state or municipality pays an additional price on a rising market of material and labor, and is credited on a falling market.

There is something to be said in favor of both of these forms and they have their earnest advocates.

Disadvantages of the Cost Plus Contract

Another form of contract used at times and in some states and municipalities, but not many, is the "cost plus" contract. Under this the contractor is paid for his time, knowledge and experience a fixed percentage based upon the cost of all the material and labor and rental of machinery that enter upon the completed work. Theoretically this would seem to be a very just form of contract, but actually no other form causes as many disputes and as much dissention. It is a trait of human nature that men will not work with the same vim and energy, will not husband their resources with as much care, will not be as solicitous for the prosecution of the work, where the costs are to be defrayed by the ample resources of the state or the municipality. However conscientious the contractor may be, he is unavoidably affected by this condition, and the men under him will not work for him in his position as quasi-superintendent for the state as well as they will work if they know it is a matter of dollars and cents to the contractor and that his vital interests are concerned. Moreover this form of contract has only too often led to scandal and adverse criticism, oftentimes unwarranted, but the general public is suspicious of collusion where there are no restraints more than can be prescribed under this form.

I know of no other methods of contracting in ordinary use. States and municipalities expend great sums in doing work under their own supervison, this is the most costly form of doing work that is known, and all records whether they be of state departments or municipal departments bear out this statement. No doubt it is necessary in small work and in small repairs for the state's forces to be employed, but the policy of engaging in work in a large way and with an expensive equipment is indefensible.

I have now briefly outlined methods of contracting for highway work that have heretofore prevailed. The title of my paper requires, or at least suggests, some recommendations as to the methods during this reconstruction period. It is very nearly impossible to offer any suggestions, lacking knowledge of what this period will produce, but I feel compelled to say that I see no method that will offer an improvement upon the lump sum bid form of contract. It is hazardous to the contractor, it has proved troublesome to the states on the forfeited contracts, although in these contracts they receive more than they pay, and it may prove somewhat more than ordinarily expensive on contracts during this period. Quick adjustments will be necessary, but I believe that the officers of the state can protect themselves so that the average will be just.

Perhaps the contractor in this reconstruction period will have more chance of making a large profit than of making a large loss, but that is not assured, no one can absolutely determine it or the bids to follow would be made in accordance with it. Every contractor knows that his business is a hazardous business. There is a gambling instinct in every man, those in whom it is most highly developed become contractors; most of them take losses and gains with a certain equanimity rather bewildering to men engaged in other lines. Every newspaper article that mentions a contractor speaks of him as a "rich contractor." Did you even know a rich contractor? There may be some, but there are only just about enough to make that exception which proves the rule. And yet, with all

the ups and downs, trials, tribulations and hardships, and uncertainties of bidding, I believe that in the reconstruction period and in all other periods, contractors would prefer to take their own chances as to the wisdom of their own judgment and the accuracy of their own figures, estimates and deductions.

The foregoing matter is the major portion of an address delivered at the 16th Annual Convention of the American Road Builders Association, Feb. 25, 1919.

Five More States Report Their 1919 Road Plans

Twenty-five state highway engineers reported their plans for 1919 in the February number of Municipal and County Engineering (pp. 46-51). This article gives the plans of five additional states:

Florida

Wm. F. Cocke, State Road Commissioner, submits the following data as to road and bridge construction work in Florida during 1919:

"Unfinished work to be completed this season: Bridges, 7; roads, sand-clay surface, 14 miles; macadam, 2 miles; bituminous, 2 miles; concrete, 7.5 miles; brick, 4.5 miles; asphalt, 29 miles; other types, 11 miles. Probable cost of work to be completed during 1919, $656,545.

"Contracts let but work not yet begun: Bridges, 1; roads, sand-clay, 35 miles; brick, 12 miles; other types, 6 miles. Probable cost, $360,000.

"Work ready for contract or force account: Bridges, 4; roads, grading or earth, 22 miles; sand-clay, 24 miles; macadam, 20 miles; bituminous, 3 miles; other types, 5 miles. Probable cost, $283,000.

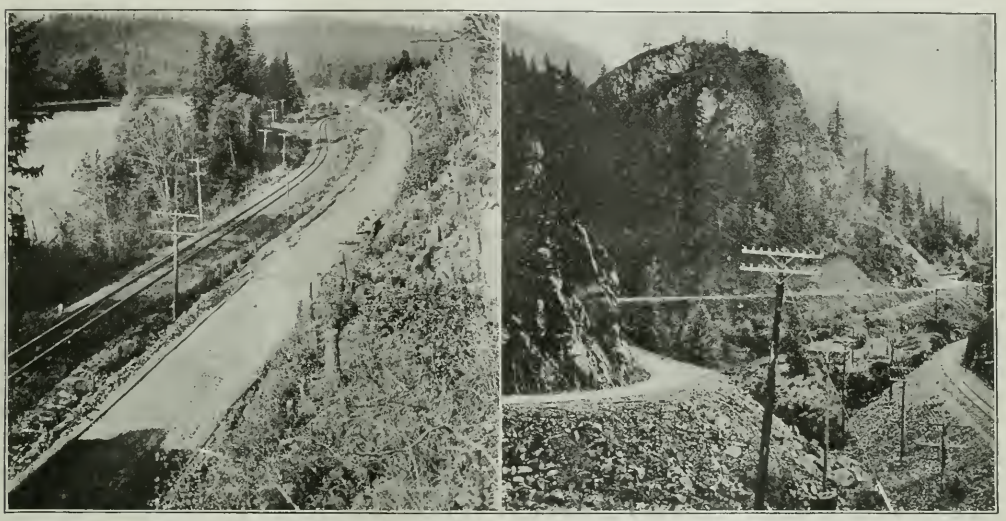
"Contemplated work, not included in above: Bridges, 2; roads, grading or earth, 12 miles; sand-clay, 8 miles; macadam, 10 miles; concrete, 15 miles; brick, 36 miles; asphalt, 42 miles; other types, 10 miles. Probable cost, $919,000.

"Total probable amount of work in State *not* under supervision of State Road Department:

"Construction, 414 miles; probable cost, $2,895,800. Maintenance, 11,070 miles; probable cost, $885,600.

"Total probable amount of maintenance work by or under State Road Department, 2,340 miles; probable cost, $280,000.

"Grand total road and bridge approximate expenditures will be from: State, $798,334; Local, $4,622,339; Federal, $859,272. Total, $6,279,945."



VIEWS OF IMPROVED HIGHWAYS IN THE STATE OF OREGON.

Ohio

H. D. Brunning, Chief Highway Engineer, Columbus, submits the tabulation herewith showing the proposed road and bridge work for the season of 1919 in the State of Ohio under the supervision of the State Highway Department.

Oregon

Roy A. Klein, Secretary Oregon State Highway Commission, Salem, submits the following statement covering highway construction in Oregon for the year 1919.

"The Oregon Legislature has passed a highway bonding bill which provides for $10,000,000 in highway bonds to be issued during the next five years. In addition to this sum, there is a balance of $3,500,000 yet to be expended, proceeds from the

PROPOSED ROAD AND BRIDGE WORK IN MISSOURI FOR SEASON 1919

Construction work under State Highway Department.

	Bridges Number	Types, Mileage: Grading or Earth	Sand Clay	Gravel	Macadam	Bituminous	Conc.	Brick	Asphalt	Other Types	Probable cost of work to be completed during 1919
Unfinished work to be completed this season	16	176	...	381	34.2	13	7.4	...	...	54.9	$1,785,100*
Contracts let but work not yet begun	...	...	...	...	...	...	...	...	...	...	...
Work ready for contract or force account	95	521	...	293	7.8	30.5	15.9	9.7	3.7	7.6	3,104,000
Any contemplated work not included in above	..	Estimate for 1919 not yet classified.									3,000,000

Total probable amount of road work in state not under supervision of State Highway Department: †Construction, $3,000,000; maintenance, $4,000,000.

Total probable amount of maintenance work by or under State Highway Department, $200,000 (Drag), 11,000 miles.

Grand total road and bridge expenditures will be from state, local and federal funds in the following approximate amounts: State, $2,300,000; local, $7,000,000; federal, $800,000.

*Note: $220,000 of this amount expended in 1918. †Note: Based on road and bridge tax levy †Note: Chat and Oil.

PROPOSED ROAD AND BRIDGE WORK IN OHIO FOR SEASON OF 1919

Construction work under State Highway Department

	Bridges Number	Types Mileage: Grading or Earth	Sand Clay	Gravel	Macadam	Bituminous	Concrete	Brick	Asphalt	Other Types†	Probable cost of work to be completed during 1919
Unfinished work to be completed this season	1	5.59	...	0.85	46.48	24.71	33.56	35.44	...	...	$ 2,853,372
Contracts let but work not yet begun	2	...	...	...	10.05	16.79	6.78	8.42	...	...	1,017,576
Work ready for contract or force account	3	2.04	...	...	1.36	1.49	1.10	12.90	...	...	1,026,150
Any contemplated work not included in above	..	Not determined.									14,000,000

Total probable amount of road construction and maintenance work in state not under supervision of State Highway Department not known.

Total probable amount of maintenance work under State Highway Department: Miles, 3,000; $2,300,000.

Grand total road and bridge expenditures under supervision of State Highway Department will be from state, local and federal funds in the following approximate amount: State, $7,600,000; local, $13,400,000; federal, $1,680,000.

legislative act of 1917. A large part of these bonds will be expended for hard surfacing state highways.

"To provide for the payment of the principal and interest on these bonds, as well as for funds available for highway construction, the Legislature has placed a tax of 1c. per gallon on gasoline and ½c. per gallon on distillate, which it is estimated will produce $400,000 annually. In addition, the present automobile license fee has been practically doubled, which it is estimated will produce $1,500,000 per year.

"Under the original Federal Aid Road Act, the state will receive $1,180,000 from the Federal Government for post roads and $698,970 for forest roads, which will be matched with state funds. If the new Federal Aid law goes into effect, Oregon will benefit to the extent of $3,149,000 for post roads, and for forest roads, $1,150,000, in addition to the funds now provided by the Federal Aid Road Act of 1916.

"A tax of one-quarter mill on the assessed valuation of the state is also available for highway purposes.

"The State of Oregon has nearly 40,000 miles of public roads. About one-tenth of this amount is included in the state highway system. Out of this total, there has been laid to date, exclusive of city pavements, 38 miles of cement concrete pavement and 187 miles of asphaltic concrete pavement. There is a large mileage, however, of plank, broken stone and gravel roads.

"It is expected that the State Highway Commission will expend practically $6,000,000 this year and various counties in the state will probably spend an equal amount on the county roads. The Pacific Highway is the first highway in importance in the state, running, as it does, north and south, throughout the length of the state. Next is the Columbia River Highway, which follows the Columbia river from the eastern part of the state all the way to the sea.

"During the years 1917 and 1918 the work was greatly curtailed on account of war activities and the shortage of labor and materials. The labor situation is now much easier and materials and supplies of all kinds may be obtained, so that it is expected the year 1919 will be a banner year in highway construction in this state. The Highway Commission is endeavoring to start work at an early date and has already awarded 15 contracts totaling about $1,500,000, and more will be awarded each month until the entire program is covered."

Minnesota

John H. Mullen, Deputy Commissioner of Highways, St. Paul, writes:

"The layout of work in the various counties in this state has not yet been completed (Feb. 1.) However, we have complete reports from 28 counties, in which there is proposed 432 miles of grading. We have also Federal Aid projects in 13 counties, aggregating 208 miles of grading and surfacing at an estimated cost of $1,294,000. Of this there will be 22 miles of hard surfacing.

"The total funds available in Minnesota for this year are as follows:

State Road and Bridge Fund	$1,980,000
County Road and Bridge Fund	5,398,000
Federal Aid	568,309
Total	$7,946,309

"It is expected that the year 1919 will be a banner year in road construction in this state and present indications are that the only limit on work to be done will be the available labor."

Missouri

C. W. Brown, Chief Clerk, State Highway Department, submits the accompanying tabulation of proposed road and bridge work in Missouri for the season of 1919.

More City Engineers Tell of Public Works Plans

Many important letters telling of public works construction projects planned to provide buffer employment for labor during the readjustment period were published on pp. 37-46 of Municipal and County Engineering for February. The present article gives additional information of the same character:

Baltimore, Md.

Milton J. Ruark, Division Engineer of Sewers, submits the accompanying tabulation regarding the proposed construction of the sewer department of Baltimore, showing the funds included in the annual appropriation for the maintenance and operation of the sewerage system. He writes:

"The Sewer Division is connected with the Highways Department and the following figures do not include any appropriation for auditing and book-keeping or transportation, hauling and the maintenance of storage yards, which is taken out of the general funds of the Highways Department.

The Sewer Division of the Highways Department also does considerable construction for private parties, railroads and corporations. It also installs and extends storm water drains in advance of the operation of the Paving Commission, and the cost of such construction is provided from funds available for paving and improvements. As near as can be estimated at this time, the value of such miscellaneous work will amount to $200,000 or $300,000 for the year 1919.

Maintenance and Improvement of Sanitary and Storm Water Systems	$ 75,000
Maintenance and Operation of Sewage Disposal Works	51,250
Maintenance and Operation of Sewage Pumping Station	59,160
Sewer planning (to be expended only upon written order of the Board of Estimates)	5,000
400 H. P. Boiler completely installed at Sewage Pumping Station	17,000
Pipe work for 400 H. P. Boiler at Sewage Pumping Station	500
400 H. P. stoker completely installed at Sewage Pumping Station	4,500
Three 260 H. P. stokers completely installed at Sewage Pumping Station	8,600
Screening press at Sewage Pumping Station	2,000
Maintenance and extension of storm water and sanitary sewers	100,000
Locust Point Sanitary Interceptor (to be expended only under direction of the Board of Estimates)	33,326
Improvements to Lakewood Avenue drain (new concrete invert for old 24' storm water drain)	10,000
New sludge digestive tank at Disposal Works (Back River Plant)	10,000

Maintenance and improvement of sanitary and storm water systems (New Addition) 5,000

Public Works Department, Boston, Mass.

T. F. Sullivan, Commissioner of Public Works, writes:

"It is proposed to spend $1,000,000 in the construction of sewers and surface drains in Brighton, West Roxbury, Dorchester, Hyde Park, East Boston, and the City Proper during the coming season. These proposed sewers and surface drains will vary in size from 12 in. pipe sewer to 10 ft. circular concrete conduit.

"In the Highway Division it is proposed to widen and reconstruct streets at an estimated cost of about $1,100,000. In adition to this, we have an unused appropriation from last year of $850,000 for the repaving of main traffic thoroughfares; also we propose to spend about $1,000,000 additional in the repaving of other streets.

"In the Water Division it is proposed to spend about $1,000,000 for maintenance and construction.

"In the Bridge Service it is proposed to spend about $600,000 for the reconstruction and repair of bridges, and plans have been prepared for the construction of a sea wall bulkhead in the Roxbury Canal, at an estimated cost of $202,000.

"In the Ferry Service it is proposed to expend about $110,000 for extraordinary repairs involving the reconstruction of ferry boats, repairs to drops, etc."

Memphis Tenn.

H. H. Hull, City Engineer, writes:

"We have not yet prepared our budget for the ensuing year but are working on it and hope to have our plans fully outlined within the next 30 days (about April 1.) It may be safely stated, though, that the city will, during this year, expend from two to five hundred thousand dollars on street repair and improvements. Our streets are in fair condition considering the obstacles that we have had to overcome in securing material and labor, but at the same time there is a great deal of work to be done and I am satisfied the Commission is cognizant of the fact that heroic steps must be taken to get the streets back into their normal condition.

"It may be interesting for you to know that the City of Memphis and the County of Shelby jointly propose the construction this year of an auditorium building to cost approximately $750,000. Bonds for same will be offered for sale on the 25th of March.

"I am sure that you can safely state that Memphis will keep abreast of the times and will not be lax in endeavoring to do all that is possible in promoting and executing work so as to join with the other municipalities in assisting to have conditions return to normal."

Yakima, Washington

Orpheus C. Soots, Executive Secretary of the Yakima Commercial Club, writes:

"We agree with you that times will be just as good as we make them. The Yakima Commercial Club, realizing that needed building operations of all kinds should be started without delay, has launched a building campaign which is already meeting with very satisfactory results. Nearly half a million dollars worth of road construction will be carried on in this county within the next few months, contracts for which have already been let. The municipality is also planning on a large program of development in the way of sewer extensions, paving, sidewalk building, etc., in the city. Numerous residences, warehouses, and two or three business blocks are being planned for early construction."

Harrisburg, Pa.

M. B. Cowden, City Engineer, writes:

"The late war has certainly put Harrisburg in a bad position as far as doing any new work in this city, this year, is concerned. We will probably pave 10,000 yards of streets with sheet asphalt, and construct $5,000 worth of sewers, and in repairing streets $30,000 will certainly be spent.

"We have a loan to put before the people for paving intersections and non-assessable properties, but it will not be available until 1920.

"If, in letting the 10,000 yds. spoken of, we do not find the prices too high, in all probability we will do at least 10,000 yds. more of paving, and double the sewerage work.

"The State of Pennsylvania is contemplating the building of the State street overhead bridge which will cost $2,000,000; and various improvements in what is known as Capital Park Extension Zone."

Binghamton, N. Y.

W. Earl Weller, City Engineer, writes:

"The City of Binghamton proposes to expend during the coming season about $60,000 on the construction of small sewers, about $25,000 on permanent creek protection and about $40,000 on penetration macadam roads. The above work is practically certain. There is also a considerable amount of potential work but it is extremely difficult to awaken the taxpayers to the advisability of proceeding with this work at the present time. I believe that the Federal Government acting through the Department of Labor should inform itself regarding all potential public works and then, by sending representatives to the various cities lend the weight of the National Government to secure the early adoption of the legal steps to make the necessary work possible."

Brockton, Mass.

Harold S. Crocker, City Engineer, writes:

"The City of Brockton, through its Highway Commissioners, will build 13,700 yds. of block paving, and a possibility of building 5,500 yds. more; 5,500 yds. of concrete road; 37,500 yds. of asphalt macadam (penetration method), with a possibility of 50,000 additional yards.

"The drainage work contemplated consists of 1½ miles of stream to be straightened, widened and deepened, below the city limits; and they also have $10,000 with which to build small pipe drains, culverts, etc.

"The Sewer department expects to lay about two miles of street sewers.

In addition to the street surfaces, about 4,000 ft. of curb and gutter will probably be laid, and also about 6,000 sq. yds. of granolithic sidewalk."

Fall River, Mass.

Albert Wolstenholme, City Engineer, writes:

"In answer to your inquiry of January 17, would say that 'No definite schemes of improvement have yet been decided upon in this city.'

"There is a very strong feeling, however, that notwithstanding the high cost of materials and labor, work of a public nature should be pushed to help bridge over the unsettled period that has come as a result of the cessation of war activities.

"In this city the work will be surely in the line of increased sewer and street construction, and some other prospects are talked of but have not yet assumed definite shape."

Waterbury, Conn.

R. A. Cairns, City Engineer, writes:

"Much work is contemplated by the city, but none has been definitely ordered. It is expected that three or four fire engine houses, one or more school houses and some smaller buildings, such as department garages, etc., will be built this year. A bond issue of $500,000 is intended for street improvement work, largely paving. This is reasonably certain. There will also probably be a $3,000,000 bond issue for reservoir and pipe line."

Waterloo, Iowa

G. H. Kilpatrick, Asst. City Engineer, writes:

"The City of Waterloo contemplates some public work the coming season and the following is being considered:

"A steel reinforced concrete 5-span bridge across the Cedar River between Cedar River park and Sans Souci park.

"There is at present under consideration 95,000 sq. yds. asphalt paving, 19,273 sq. yds. of asphalt paving to be re-

surfaced, 48,400 lin. ft. of combined concrete curb and gutter, 8,665 lin. ft. of combined sewer and approximately 3 miles of cement sidewalks 5 ft., 4 ins. wide.

"The River Front Commission will build about 500 ft. of sea wall but as no plan has been decided upon at this time, very little of a definite nature can be given."

Battle Creek, Mich.

Edward Hoyt, Asst. Engineer, writes:

"It is proposed to construct about 45,000 sq. yds. asphaltic concrete pavement and about 8,000 sq. yds. of brick pavement. We will also construct one reinforced cement arch bridge over the Battle Creek river at Emmett St. In addition to the above we will construct the usual amount of curbing, sidewalks and sewers but am unable at this time to give any stated amount."

Jackson, Miss.

M. L. Culley, City Engineer, writes:

"No new construction work is proposed for 1919, except the repairing of about 15,000 yds. of street paving, probably resurfacing the old brick and asphalt pavement with sheet asphalt. Shortage of funds prevents any extensive construction program."

Flint, Mich.

Ezra C. Shoecraft, City Engineer, writes:

"We will do the following work in this city during the coming season: 105,000 sq. yds. of pavements, estimated cost, $350,000; 15 miles of sanitary and storm water sewers, estimated cost, $350,000; 400,000 sq. ft. of sidewalks; 1 reinforced concrete arch bridge; 20 miles of water mains."

Cedar Rapids, Ia.

T. F. McCauley, City Engineer, writes:

"Our certainties are three miles of 5 ft. cement walk and about ½ mile of sanitary sewers. An almost assured project is a concrete bridge across the Cedar river that will cost approximately $250,000, and we also contemplate the construction of $150,000 worth of concrete storm sewers."

Port Huron, Mich.

Earl Whitmore, City Engineer, writes:

"Our program for 1919 calls for quite extensive street improvements, but has not yet been definitely determined.

"The following are quite certain of construction: Lapeer Ave. from 16th to 24th Sts., 28ft. wide brick or concrete, Twenty-Second and Railroad Sts., about 8 blocks 28 ft. wide, brick or concrete.

"In addition to these two streets the following are under consideration with a good prospect that a considerable portion of them will be built:

"Pine Grove Ave., about ¾ mile long, 18 ft. wide, concrete: Stone St. and Garfield St., 9 blocks long, brick or concrete; Scott Ave., 7 blocks long; Tenth Ave., 11 blocks long; Michigan St., 6 blocks long; Park St., 4 blocks long; Commercial St., 1 block long; Crescent Place, 2 blocks long; Pine St., 10 blocks long; Fourth St., 5 blocks long; Jenkinson St., 1 block long. Also an alley or two.

"This paving, except as otherwise stated, will average about 30 ft. in width and probably a good deal of it will not be built this season. We should know within three or four weeks (by April 1) quite definitely, which streets will be built."

Aberdeen, S. Dak.

Frank LeCocq, City Engineer, writes:

"Plans about completed for $300,000.00 storm sewer system. Bond issue to be voted on next April. It looks as if it will go thru. Sewer from 18 ins. to 9. ft. in diameter."

Asheville, N. C.

B. M. Lee, City Engineer, writes:

"The City of Asheville, N. C., have so far ordered the following work to begin in the spring: Street paving, Durax, 13,900 yds.; street paving, concrete, 26,830 yds.; sidewalks, cement, 13,000 yds.

"Will probably order other work later but I cannot tell the amount."

Eldorado, Kans.

Bert C. Wells, City Manager, writes:

"We will probably pave about 40 blocks, 50,000 sq. yds. Will build some sewers, amounting to approximately $50,000. Will lay a large quantity of sidewalk.

"A large number of buildings are being planned for this summer."

Pueblo, Colo.

D. P. Gaymon, City Engineer, writes as follows regarding proposed municipal improvements for 1919 in Pueblo:

"The reasonably certain work to begin and complete by Nov. 15, 1919, will be two paving jobs, the specifications for which we have just completed. One district will be 40,500 sq. yds. of bitulithic on crushed rock base, with 18,000 ft. of combined concrete curb and gutter, and a $9,500 sewer job.

"The other job of pavement will be 27,100 sq. yds. bitulithic pavement, laid on a concrete base, 11,600 ft. of combined concrete curb and gutter, $3,500 in storm sewer.

"The city authorities are certainly in favor of all work that is designed to act as a safety valve for the high pressure at present developing in the field of labor."

Twin Falls, Ida.

E. V. Berg, City Engineer, gives the following data on work in Twin Falls, including pavement, sewer and bridge:

"The location of the pavement is largely in the residence district though a number of alleys in the business section will also be paved. There will be approximately 6 miles of first grade pavement such as asphalt, bitulithic or concrete and in the bituminous macadam class. The total amount of pavement work which it is contemplated doing is in the neighborhood of 200,000 sq. yds. Bonds have not yet been voted for this improvement but there is no serious opposition anticipated. The total cost of this work will run in the neighborhood of $600,000.

"The city also expects to add a new trunk line to its sewer system, as well as several lateral sewer districts. A string of additions have been added to the city on the north and east sides in recent years and it has become necessary to provide these districts with a main trunk line. The cost of this improvement will be about $40,000.

"The matter of replacing the wood trestle across Rock Creek, within the city limits, with a steel bridge has also been considered and if not done this summer will surely be done within the next year or two. This bridge at the present time would cost in the neighborhood of $75,000."

Newspaper in Strong Plea for Permanent Highways

That the newspapers of the country are becoming convinced of the unwisdom of building temporary roads is accurately reflected in the following editorial from a recent issue of the Valdosta Times, of Valdosta, Lowndes County, Ga.:

Lowndes county, last year, spent between $40,000 and $50,000 on public roads. Most of it was contribution to the sand-swapping process which has gone on under the good roads idea for several years. We admit that it was better work than was formerly done. It is a movement in the right direction. Many of the roads were straightened and graded, the wet places filled-in and the sand beds were buried. The roads we have now would have filled our hearts with joy 25 years ago, when a trip from Valdosta to Habira was about a Sabbath day's journey. A man who lived 25 miles away had to bring his camping outfit with him and return home about the third day after leaving.

But that was in the long ago. It was before the advent of the automobile, the motor-plow and the farm truck. It was in an age when time did not count for much. The wear and tear of vehicles and horses were not figured in the expenses of the farm. The increased value of land as a result of good roads was no incentive, as most land-owners wanted to buy more land and let it remain in idleness or only partially cultivated. Everything was different then from what it is now. The sandy trails through the woods were the only roads we had or

thought abont. To make them clear of roots and stumps was our idea of good roads. We have progressed since then. We have been climbing upward all the time. First, it was the "potato ridge roads" then followed the "burial of sandbeds." Then came the sand-clay roads and later the graded, straightened, 30-ft. highways which do good service when the weather remains good and the roads are worked.

But these roads are only a beginning. They are just good enough to make us want permanent roads—roads that will stand all sorts of weather and which will not be in need of constant repair. Snch roads will cost money, but no more than we are wasting every year on roads that are not permanent. The $46,000 we spend annually on sand-clay roads would pay the interest on more than a million dollars worth of bonds for permanent work, Or, if we had started putting $25,000 a year in permanent roads ten years ago we would have had $250,000 worth of paved roads by now. We would have had the nucleus of a system of public highways that would have made Lowndes county one of the greatest counties in the state.

It is time that we were spending our money on roads that the first shower will not make impassable. A million dollars in bonds would bring many millions of increase in values to this county. It would put the cost of roads upon posterity, which is to enjoy the advantage of such an expenditure. It would cut down the amount of time lost jogging along the washed out roads and would also save an untold amount of loss from wear-and-tear on vehicles of every kind. It would enable the farmer to get to market quicker and carry much larger loads on his wagon. It would help all of the communities of the county, adding to the value of property and increasing the desirability of rural homes. It would impose no burden upon anybody. We would never know that there was a bonded indebtedness hanging over the county. We are hopeful that Lowndes will become interested in permanent roads and that the people will not rest until they get them.

Design and Constructional Features of the Baraga Road in Baraga County, Michigan

By G. C. Dillman, District Engineer, Michigan State Highway Department, Escanaba, Mich.

The road situation in Baraga county up to a few months ago was as follows:

The equalized valuation of Baraga county is $5,600,000 with an allowed trunk line mileage of 75.6 miles. From this we have the valuation per trunk line mile of but $74,074, which is one of the lowest in the upper peninsula of Michigan.

To the north and west of Baraga county are the great copper mines. On the east and south are the iron ranges. These mining counties, with an abundance of improved highways completed in most part to the Baraga line, had no connecting road other than the "bump-providing, rough-on-riding" roads of Baraga.

As a result there had been considerable condemnation of these roads by the traveling public, some of which was not warranted. The main connecting road lay through an exceedingly rough conntry, there being many excessive grades and dangerous turns. The conuty though working under the county road system, had neither organization nor money to spend. Hence, the outlook for an improved road across the county looked rather distant.

In the fall of 1916, after federal aid was assured, State Highway Commissioner Rogers called a meeting at Marquette and proposed to place considerable of the upper peninsula portion of this money in Baraga county. Representatives of nearly all the upper peninsula counties were present at this meeting and most of them were in accord with the proposition.

In the meantime, a survey had been ordered made for a road across Baraga county which was completed in the early winter of 1916-1917. Then, with the necessary constitutional amendment, the 1917 Legislature provided for the construction, maintenance and improvement of federal aid roads.

Thus, with Federal and State aid in sight the county bonded for $110,000 to meet its portion of the cost of building this road. The original estimate of cost was $417,080.40, the county being called upon to pay, in this case 25 per cent., or $104,270.10. The estimate does not include the cost of building five concrete and steel bridges.

Federal Aid Road No. 3

This road, known as Federal Aid Road No. 3, commences at the south line of Houghton county, extending in a southerly and easterly direction to Michigamme, on the west line of Marquette county, a distance of 48¼ miles.

The present project includes grading, building of all drainage structures and laying of ¾ mile of cement concrete pavement in each of the villages of L'Anse and Baraga. When this is done the balance of the road will be surfaced with stamp sand and gravel. In the meantime the new grade will be kept in reasonably good condition for travel.

For convenience the road was divided into four sections, namely, A, B, C, and D. Contract for the whole was let April 16, 1918. The Smith-Sparks Construction Company of Houghton were given the contract for sections A and B, a distance of 19.2 miles. M. J. Bacco of Iron Mountain was awarded sections C and D, 29 miles in length. All work is to be completed by Jan. 1, 1920.

Section A

Section A extended from the Houghton county line south to station 614 + 30, a distance of 11.6 miles. The new survey holds fairly close to the old road, the only changes being made to improve the alignment and to get better railroad crossings. There is no deflection whatever in the north five miles as this is an old base line.

The predominating soil is clay with occasional sand areas. There is 850 ft. of 7 per cent. grade at Keweenaw Bay which could not be avoided due to there being two railroad crossings at the upper end, with a lighter grade continuing for another 1,500 ft. This grade is all in fill varying from 2 to 7 ft. and was made with stamp sand obtained locally. Making embankments with stamp sand where it is available has not been the general practice, yet we had excellent results.

Stamp sand is composed of small particles of copper-bearing rock, stamped to sizes varying from silt to ⅛ in. generally cubical, from which the metallic copper has been washed. The rock is similar to diabese and trap.

The heaviest work on this section was the cutting down of "Fuseville" hill to 6 per cent. grades. This was mostly a side hill cut and meant the moving of 10.000 cu. yds. of dirt. To take care of traffic it was necessary to "step" down the cut which slowed up the work somewhat, yet with Maneys and drag scrapers good progress was made.

This section takes you along the old Indian Mission at Assinnius and follows close to Keweenaw Bay the entire distance.

The surfacing will be two-course stamp sand, the construction being similar to ordinary sand-clay work.

Section B

Section B extends from station 614 + 30 to station 1014 + 00, a distance of 7.6 miles. This too, mainly follows the old road.

Seventy stations lie at the edge of Keweenaw Bay, requiring 15,000 cu. yds. of fill to put the road bed sufficiently above high water. This is an overhaul job, the average overhaul distance being 3,200 ft. Cars and track will be used, the dirt being loaded with a steam shovel. Considerable of the fill on the bay side will need rip rap, field stone and ledge being taken from the road side north of Baraga to be used for the purpose.

The road crosses a bayou where an 84 ft. steel truss bridge is being built. At one place in the channel the water is 45 ft. deep. At times the flow in the channel is in one way, at others

in the opposite direction. Long, straight abutments without wing walls were built on piles, the plan being to surround the piles with stone and rip rap the backfill heavily.

Probably the most difficult construction on this section will be that of building the road along a sand stone bluff north of L'Anse. The bluff rises 20 ft. or more vertical on the west side, on the east the bay being 20 ft. below. The South Shore Railroad is at the upper edge of this bluff, hence we could not cut further into the rock, so will build 700 ft. of concrete retaining wall to enable us to get the full grade width. This will be a plain gravity section, 10 ft. high and 6 ft. on the base. A trench will be blasted into the rock underlying the bay to insure a good footing for the wall.

As stated before, three-quarters of a mile of cement concrete pavement will be laid in each of the villages of L'Anse and Baraga. In L'Asne there is 550 ft. of 8 per cent. grade on which concrete will be laid. This is on a residence street and to get this grade it required a maximum cut of 8.5 ft. at the center. Then a village water main was uncovered which had to be lowered at a cost of about $1,000.

Concrete curb and gutter will be built adjacent to the pavement on this grade and the cut was taken out sufficiently wide to allow for a 4.5 ft. walk on either side.

Surfacing for the balance of this section will be stamp sand and gravel.

Section C

Section C lies wholly through hardwood forests. It extends from station 1014 to station 1895, a distance of 16.7 miles and is all new location.

A few miles of this has been cleared and a mile or so grubbed. The soil in general is loam and quite free from rock. However, the south mile is a veritable nest of boulders. Ditches cannot be put in economically on this and money can be saved by filling 1.5 ft. or more over such places. Gravel will be used for surfacing.

Section D

The balance of the road, section D, extends from station 1895 to the Marquette county line, a distance of 12.4 miles. It is rather rough and there are considerable boulders the entire length of the section.

Much of the old road through here has been given up in favor of a new location, and in so doing four grade crossings have been eliminated. To eliminate these crossings, however, took a great deal of time on preliminary surveys through a rough country, and it meant building over a granite and trap bluff and for 700 ft. across a lake.

The road extends along this rock ridge for a mile, paralleling the South Shore Railroad. As the centerline of the highway is but 83 ft. from the railroad it has been necessary for the contractor to station flagmen half a mile in either direction along the track when blasting as a "safety first" measure. Something like 5,000 cu. yds. of solid rock will be taken out in this mile.

In filling across the lake gravel from a nearby bank has been used. This runs rather coarse, containing boulders up to 1 cu. ft. or so in volume. Care has been taken in doing this work to keep the larger stone at the edge, thus building up a good rip rap. This section, too, will be surfaced with gravel.

On this fedetral aid road there will be eight railroad crossings, all at grade. Besides the four crossings, eliminated as before mentioned, five yard tracks have been avoided at L'Asne by a new location. In all other cases an attempt has been made to improve the existing crossing by clearing the immediate site of all brush and trees, building up the road grade and increasing the angle of crossing where possible, at the same time being consistent with good alignment.

The grade width throughout will be 24 ft., shoulder to shoulder. A flat subgrade section is used, the ditches averaging 2 ft. in depth and 2 ft. on the bottom.

Clearing consists of close cutting all brush, trees and stumps, on a minimum width of 50 ft., measured 25 ft. each way from the centerline of the roadway. This will not only give the right-of-way a better appearance but, in many cases, will prevent snow from drifting.

At times we find it hard to enforce the clause in the contract in regard to the burning of brush, etc. The fact that it will not burn when too wet and the State Fire Wardens and others not permitting it's burning when the weather is too dry calls for some other means of disposal. However, we insist that if it is not burned it shall be so placed that it will not be an eyesore to travelers.

The contractors began work about May 1, 1918, and during the following seven months 29½ miles of grading were completed. There is also considerable work in an unfinished state.

VIEWS ON CONSTRUCTION OF BARAGA ROAD, BARAGA COUNTY, MICHIGAN, FEDERAL AID PROJECT NO. 3.

To give some idea of the amount of work to be done under the present project agreement, I have listed a few of the items entering into the work as follows:

Rock excavation—10,500 cu. yds.
Earth excavation—267,600 cu. yds.
Concrete in culverts—2,571 cu. yds.
Culvert pipe—3,474 lin. ft.
Guard rail—29,316 lin. ft.
Clearing (Sec. C & D)—125 acres.
Grubbing (Sec. C & D)—14.927 sq. rds.
Overhaul—534,828 yard stations.

All work is slope staked. Stakes are placed at the center and at the outer ditch slopes or at the foot of fill in case there is no ditch. This method has worked out exceedingly well.

Had it not been that the contractors were able to place a good many station men on the work I doubt whether much would have been accomplished the past season. The fact that railroad grading was almost at a standstill forced many men to seek other employment and naturally they took to highway grading.

Station men usually work two or three in a party, a few few stations or occasionally a mile of grading being sublet to them. One man will move on an average around 15 cu. yds. of dirt per 10-hour day. Their equipment generally consists of wheel-barrows, shovels, picks and a few lengths of plank on which to run the wheel-barrows, all being furnished by the con-

tractor. They try to move all dirt directly across the road, their "free haul" distance usually being 50 ft. Here is where close inspection is required lest many unsightly borrows are made with a corresponding waste of dirt in other places. However, I am convinced that for good, clean-cut work we would do well to employ more station men.

As stated, the plan is to surface practically all this road with stamp sand and gravel, 16-ft. in width. The construction will conform with our state specifications for class "A" roads.

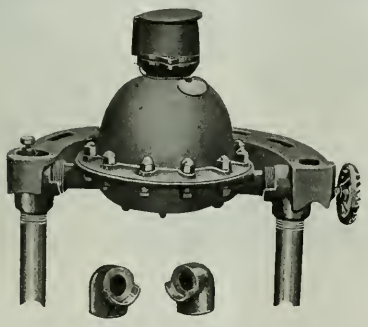
A traffic census taken during the summer of 1918 at the Houghton and Marquette county lines, namely, the north and east ends of the Baraga road, show from 75 to 200 vehicles per day. This, too, when half the road was under construction. So with the road completed it doubtless will have a traffic of double that number of vehicles.

Acknowledgement

The foregoing paper was presented before the recent annual convention of the Michigan Engineering Society.

The McNutt Meter Holding Yoke

The McNutt meter holding yoke places the riser pipes on 9-in. centers, which is as close together as they can be brought and therefore farthest from the frost line. This yoke, here illustrated, is simple and convenient and can be installed by any laborer. The yoke is furnished with sole leather gaskets ready to install. With this yoke a ¾-in. meter can be set in a 15-in. sewer pipe with a 15-in. cover, and a 1-in. meter can be



McNUTT METER HOLDING YOKE

set in an 18-in. sewer pipe, using the 15 and 18-in. McNutt covers, respectively. If these installations are made according to instructions the meter will not freeze. A written guarantee against freezing is given with each setting. These meter-holding yokes are manufactured and marketed by the McNutt Meter Box Co., Brazil, Ind.

Road Maintenance by the Patrol Method in Maine

By Paul D. Sargent, Chief Engineer, State Highway Commission, Augusta, Maine

During the last three years our road maintenance work has been done by the patrol method. We have entire charge of the work. We hire patrolmen and pay them direct from the Highway Department and all of their reports are made to the Highway Commission. At the end of the season, we make a report to each town showing just what work has been accomplished so they can see how their maintenance money has been expended, said Mr. Sargent in a discussion before the recent joint Highway Congress in Chicago.

Hiring Patrolmen

In the hiring of patrolmen we first ask the municipal officers of each town to recommend three men who in their judgment would be suitable to do the work. We had a brief statement with respect to each man as to his age, height, weight, health, nationality, and previous experience, also as to his location with respect to the road to be patrolled.

Our supervisor then went into the town, interviewed the men and hired the man who seemed to be best fitted to do the work. Frequently none of the men recommended by the municipal officers was found to be suitable and then the supervisor hunted around until he found someone.

Reports by Patrolmen

Instructions quite in detail are sent to the patrolmen each spring and they are visited as often as once in two weeks by one of our supervisors. They are required to make a report once a week showing what they have done each day, together with the condition of the weather. In this way the supervisor, who has charge of about 25 patrolmen, is able to keep in touch with the work. The reports after being looked over by the supervisor are sent to the Highway Commission office where the superintendent of maintenance finally reviews them and places them on file.

Patrolmen are paid once a month and the time which they send in at the end of the month has to agree with the weekly reports previously filed both as to time worked and as to classification or distribution of the labor.

Patrolmen's Wages

In 1916 patrolmen were paid $75 per month. For this they furnished one horse weighing not less than 1200 lbs., a drop axle wagon, and the necessary hand tools, and a drag built for one horse. During 1917 and 1918 we worked over into allowing patrolmen to use two horses, more or less. At the end of 1918 one-third to one-half of our patrolmen are hired with two horses and the men who regularly work one horse are authorized to employ an additional horse to do the dragging. During 1918 we started in paying patrolmen with one horse 44 cts. per hour and with two horses 55 cts. per hour. Due to abnormal labor conditions prevailing and to stabilize our patrol force, we made an agreement with every patrolman when we hired him this year that we should pay him only 95% of his wages each month. The remaining 5% was to be held back until the end of the season and to be paid him in a lump, provided he remained through the entire season. In case a man was discharged on account of unsatisfactory work he was not to receive this 5%. We have had very few resignations and it has been necessary to discharge but a very few men. On the first of September 1918 we increased the patrolmen's rates of pay to the following amounts: 50 cts. per hour for a man with one horse and 60 cts. per hour for a man with two horses.

Cost of Patroling

During the year 1916 we employed 373 patrolmen and had under patrol 3,466 miles of road. The total expenditure was $286,399 and the average expenditure per mile was $77.43.

During 1917 we employed 437 patrolmen caring for 3,705 miles of road. The total expenditure was $432,716.00 and the average expenditure per mile was $117.19.

During 1918 we have employed 480 patrolmen caring for 4,250 miles of road. I am not able to give the total expenditures but they will be about $500,000, making an average expenditure of a little over $140 per mile. These increased costs are due to the increased cost of labor and material. A little rough figuring indicates that our labor costs have averaged about 34% over 1917, which would give us roughly an average cost per mile for maintenance this year of $157.

Our patrolmen show on the weekly reports the amount of time which they have spent each day on the improved road and on the unimproved road under their care. In this way we are able to control the expenditure and to keep it in about the right proportion on the different classes of road. Under our law, towns are obliged to pay toward the maintenance of state highways $60 per mile per annum provided the expenditure amounts to that, and on improved state aid roads $30 per mile per annum, the state paying the balance.

I think it is fair to state that we have approximately 100 miles of state highway which we surface treat each year, using Tarvia B and sand. The cost of preparing the road, making the surface application, and then keeping the road patched and the shoulders in shape through the season has averaged during the last three years from about $650 per mile in 1916 to $850 to $900 per mile through the present season. These figures are all included in the averages which have been given above.

Machine for Removing and Loading Pavement as Operated by the United Railroad of San Francisco

By L. M. Edholm, 68 Buchanan Place, The Bronx, New York, N. Y.

The United Railroad of San Francisco has a specially constructed machine for removing the paving between their tracks. As a time and labor saver the machine more than pays for itself in a very short time. This apparatus consists of a scoop measuring 34 ins. by 63 ins. This is supported at the front end on a small iron frame on wheels. At the top end it has an eye which fits the coupling on a car. Any work car can be used. A platform 4 ft. wide and 15 ft. long extends from the car to the scoop and this has an incline of about 25 degrees,

VIEWS OF MACHINE USED TO REMOVE PAVING FROM BETWEEN RAILS.
Left: Ready to Begin Operations. Right: Machine in Operation.

The edge of the scoop is somewhat sharp with an up-turned edge and this is forced under the concrete to start the work. Then the car proceeds on its own power, the scoop shoving ahead under the layer of asphalt and concrete and raises it in a long strip which is forced up the incline and drops into the bottom of the car. When this end of the car is filled the scoop attachment is placed at the other end of the car and the same process is repeated until the car is full. Two views of the machine are shown herewith.

How Motor Freight Transportation Aids Road Improvements

By H. P. Branstetter, Kissel Motor Car Co., Chicago, Ill.

A community without good roads is an isolated community, becoming more isolated as the railroads are asked to haul more and more supplies and materials for the government, as well as for the manufacturers doing government work. Communities should realize this now and "put their roads in order" before next fall and winter.

A Specific Example

There is a motor truck transportation company in the South that is installing motor truck lines between cities and communities. Before each line or route is put into operation the officials of the company go to the community which they have in mind tying up with other communities and point out to local shippers the advantages and saving which motor truck transportation will enable them to make.

After they have "sold" the idea, after the shippers and merchants of this community decide they need motor truck transportation, and after they have guaranteed a necessary amount of business sufficient to warrant the motor truck transportation company operating there, the transportation company turns around and says in effect: "The roads between here and the town nearest to where our trucks are at present operating are poor roads. They are too bad for us to operate over profitably. They would make our transportation rates to you prohibitive. Before we can give you the kind of service you need, it is up to this community to make these poor roads good roads." This company is finding that in practically every instance where they make this proposition, the people of that community see to it that the roads are put in good shape, so that the transportation company can operate over them.

Truck owners know that good roads not only save money for them, but for the shipper and public as well, since good roads make possible faster time, at a saving in operating expense. This was recently proven in a test between two trucks of the same capacity, same make and same load. One truck ran between two communities on good roads and the other truck operated between two communities on poor roads. It was found that the truck operating on good roads was able to deliver its load at nearly 1/3 per cent. less cost than the other and with nearly a 50 per cent. saving in time.

This saving in time and expense not only benefits the truck owner and truck operator, but the producer and consumer, because, obviously, the cheaper goods can be shipped, the cheaper they can be sold.

Self-Rotating Hammer Drills Used in Rock Trenching for Water Mains

A Hummer self-rotating hammer drill was successfully employed in digging trenches into solid rock for water mains for the Hackensack Water Company, Hackensack, N. J. A Chicago Pneumatic portable gasoline-driven air compressor supplied air.

Hummer hammer drills are made in three sizes for drilling from 6 to 12 ft. in solid rock. They have independent rotation, automatic lubrication, indestructible ball valve, and are provided with exhaust throttle for clearing holes.

Chicago Pneumatic simplate-valve gasoline-driven air compressors may be mounted on a truck for portable work. They are also furnished stationary or skid-mounted for semi-portable work. This same machine can also be furnished for operating on fuel oil and other cheap fuels.

EDITORIALS

Better Days Coming for Engineers

Of very great interest to every engineer is the progress being made toward improving the working conditions and salaries of professional engineers employed by the railroads. The railroads have always been the largest employers of engineers, and have, in large measure, set the scale of compensation for every engineer in America. That this scale was always too low and that it has been especially unfair in recent years are notorious facts. So great is the present prospect of improvement that every engineer has cause to anticipate an early and favorable readjustment of his affairs if he will but be alert and co-operate with others in working for better conditions.

A schedule of salaries for railroad professional engineers was adopted by the National Conference of Railroad Engineers held in Chicago on March 17, 1919, under the auspices of the American Association of Engineers. Following this conference there was a hearing on the pay of professional engineers before the Board of Wages and Working Conditions, U. S. Railroad Administration, March 31-April 2, in Washington. That the board will make recommendations for substantial increases in the subordinate positions there can be no reasonable doubt, but when this will be done is not certain. The principal difficulty before the board is to define the duties and responsibilities of the many positions and to establish a dollar-and-cent ratio. The board was easily impressed with the glaring injustice under which engineers have so long labored and appeared anxious to right old wrongs. From the magnitude of the task of standardizing positions and duties and fixing compensation for the various positions, it appears that two or three months may easily pass before the board will have reached a satisfactory solution of the various problems involved in the readjustment. It is interesting to note that in its memorandum to the board the American Association of Engineers not only asked that a speedy decision be reached, but that the new schedule of wages be made retroactive. Thus to our railway brethren both retrospect and prospect are alluring. There is ample precedent for making retroactive any wage increases granted the railroad engineer.

The American Association of Engineers presented at the hearing before the board the resolutions and schedule of salaries adopted at the Chicago Conference. The clause against overtime, "no pay for overtime," was the subject of a good deal of questioning on the part of the several members of the board, but the testimony of all witnesses, whether called by the A. A. E. or not, was against overtime for engineers.

The Engineering Council, an organization of national technical societies, representing some 40,000 members, recognizing that the A. A. E. represents the engineers in the junior positions in railroad service more thoroughly than does the Council, and by reason of the Chicago Conference on March 17, turned over the presentation of the case to the A. A. E. and backed it up unselfishly. There was no evidence of anything but a united front and harmonious support at the hearing. There were differences of opinion between the representatives of the Engineering Council and the A. A. E., but these were composed before the hearing. Thus it appears that engineers are now able to rise above petty rivalries and jealousies to reap the benefits of co-operation and compromise.

The hearing before the board, considered in connection with the Chicago Conference, has already demonstrated the value of a business organization of engineers such as the American Association of Engineers. Many doubters have been convinced, and are now spreading the gospel of co-operation among engineers.

It is highly important that engineers continue watchful and build up the A. A. E. so as to help "through the narrows" the recommendation for salary increases that the board will surely make.

It is again urged that all engineers support the A. A. E. by joining it. While the railroad engineer is now having his inning, the public engineer is next in line, and should insure his own future welfare by acting now on this advice to join the A. A. E.

The A. A. E. has won a great victory. The association is only four years old, yet, we call on the profession to witness, when an opportunity came to advance the entire group of railroad professional engineers the A. A. E. seized it and acted upon it. It is true that the Engineering Council co-operated in the movement and is entitled to much praise for their ungrudging support. "Old men for counsel, young men for war"—and so it was in this case. The old national societies—the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the American Institute of Mining and Metallurgical Engineers and the American Institute for Testing Materials—compose the Engineering Council and supplied the counsel in this case. That sturdy young warrior, the American Association of Engineers, was there to do the fighting, but was so fit for a fight that no fight developed, which seems to bear out the arguments of the preparedness advocates. The A. A. E. will be long remembered for this achievement. There is credit enough for all, but the unprejudiced onlooker will award most of it to the A. A. E. and he will not forget that it was the A. A. E. that not only accomplished things itself, but galvanized the older societies into activity.

At the hearing before the Board of Wages and Working Conditions of the U. S. Railroad Administration, the board inferentially raised the question: "Why have you waited so long, you engineers, before seeking relief?" We do not know how the question was answered, but the true answer is interesting and illuminating. There were many reasons why engineers waited so long. One reason was that they spent several decades in commiseration, in telling each other how badly they felt at being so little appreciated. With the discovery that this curvilinear motion was not getting them any place, they gradually started to take the public into their confidence, and in recent years a certain influential section of the general public has come to understand that professional engineers gave much and received little. With the formation and development of the American Association of En-

gineers there developed within the profession the will to advance and co-operate. Engineers are now learning to co-operate and the magnificent profession of engineering is in a fair way to receive just compensation for its services and full recognition from employers of engineers and from the great body of our fellow-citizens who make up the general public.

Engineering was always a noble calling; in growing more profitable it need lose none of its nobility.

A Modern County Engineering Problem

The utilization of the principle of the hydraulic jump or standing wave to destroy the energy of 2,000 cu. ft. of water per second precipitated over a bluff 110 ft. high, as described in this issue, serves well to illustrate the importance of county engineering work today, for this was a county problem. Those who are still thinking of county engineering work as little more than land surveying, plus road dragging and grading, will do well to note the complex nature of the specific county engineering problem under discussion, its skillful solution and the nature and extent of the requisite engineering structures.

The problem presented was of such character that its solution was handled by a prominent consulting hydraulic engineer, who was called in by the Board of County Commissioners. The spillway structure illustrated and described is so unusual that it is of exceeding interest to hydraulic engineers. How the energy of the water was absorbed without destructive effects is fully explained. The works selected comprise a paved open channel, sluiceways, a shaft and tunnel, open flume, deflector beam, and a concrete stilling basin. Where the secondary expansion takes place below the primary stilling basin the water was allowed to excavate its own secondary stilling basin. The manner of accomplishing this hydraulic excavation was most ingenious. The article will interest county and state engineers as well as consulting hydraulic engineers. It is engineering of this character that indicates the possibilities in the county field.

At New Orleans

Municipal engineering activities are well ordered at New Orleans. In this important department of city business New Orleans has set some very good examples to other American cities, as the leading article in this issue amply demonstrates. Engineering work in that city has been particularly well handled for a good many years. This reflects credit on the engineers and also on the non-technical city officials who have had the good sense not to interfere with the engineers.

Of very special interest and significance are the facts that the water, sewerage and drainage facilities of the city are under unified management and that the general superintendent of the construction and operating board has occupied his position of responsible engineering head of this Sewerage and Water Board for nineteen years. This has given him the opportunity to do much splendid work and municipal engineers throughout the country are very proud of the results Mr. Earl has achieved at New Orleans. Associated with him are many good engineers who also have been permitted to retain their offices for a good many years and have fairly won the praise of their chief and the gratitude of their community.

It is only natural that where there was much interesting municipal engineering work to do, with competent engineers to do it, that many important and helpful innovations have been introduced, some of which have already been widely adopted by other cities. Also, because of the unification of management of the three utility systems and because men in the various departments were given opportunity to exercise initiative, and, in some cases, to disregard precedent and ordinary procedure, many improvements over usual methods and procedure have been effected. Many of the more important of these innovations and improvements are described in the leading article in this issue.

The Other Man's Prices

"My prices are reasonable, but the other man's prices are altogether too high." This seems to be a very general conviction at this time. The prices in every line are high in comparison with the prices of 1916. In each line the prices are considered fair and just by those engaged in that line, but this set of men regards with suspicion the "high" prices set with equal honesty by the other fellow. Isn't it about time we realized that we are all in the same boat, as usual; that all prices are high and must be high and must continue high for an indefinite period?

It naturally comes as a surprise to find the price of a commodity much higher than when we were last interested in that commodity. In some unreasonable way it seems the price should be the same as it was before the war. It is much like revisiting the scenes of childhood to look up old friends. For years we have carried in memory the picture of a boy. How unnatural it at first seems to find that he, too, has grown to man's stature just like ourselves! A moment's reflection readjusts us; of course, the other boy grew up, too. That is the price situation in a nutshell: the other man's prices just naturally grew up, too.

War Trucks Will Not Drug Market

In case public works contractors or local authorities are delaying the purchase of motor trucks in the expectation that they will have the opportunity to purchase at bargain prices motor trucks used for the transportation of men and materials during the war, they should abandon this idea, for it is reliably stated that such trucks will not find their way back into the market.

It should be remembered that war trucks were subjected to such hard usage that when discarded from military service they are, in most cases, unfit for further use. Some trucks are overhauled and kept in service, which is still going on, but many are scrapped on the ground without even being taken to a salvage dump. These worn-out trucks will have to be replaced by new trucks, and it is doubtful if the number of trucks now contracted for will be sufficient to take care of present needs.

The ending of the war has not relieved transportation difficulties in Europe. The army of occupation must be served and the large present and prospective troop movements rather add to transportation demands. The feeding of the central empires also calls for much trucking, as does the return to their homes of refugees. There is to be much real "reconstruction" in Europe, and until the devastated regions are restored there will be no falling off in the use of trucks in Europe.

In view of these facts, those who need trucks should go into the market for them now.

Unique Features of Unified Operation of Water, Sewerage and Drainage Facilities at New Orleans, La.

Many Innovations and Improvements Over Usual Methods and Procedure

By George G. Earl, General Superintendent, Sewerage and Water Board, New Orleans, La.

The city of New Orleans, starting with its drainage problem in 1895 and with its sewerage and water problems in 1900, to date, has expended about $32,000,000 in the construction of these systems, and now has something like 2,200 miles of underground sewerage, water or drainage arteries of various kinds under its maintenance, and some 18 pumping stations, two power stations and two water purification stations in operation, all involving operation expenditures of about $1,000,000 a year.

Drainage Work

The drainage work was started by the New Orleans Drainage Commission, and when sewerage and water systems were undertaken this drainage commission was made a part of the sewerage and water board, with provision for early merging of the two boards, which was effected in 1903, and resulted, as a whole, in a unification of management from the very inception of the original drainage construction and in the consistent development of the work on all three systems by forces which have been continuously employed upon them, first in planning the original works, then in their construction and in their maintenance and operation, and finally in their gradual extension and improvement.

Extent of Drainage Works

As a result of these works, over 30,000 acres of land, all of which is from 8 to 22 ft. below high water in the Mississippi river, which bounds the city on its south side for a distance of about 11 miles and two thirds of which is below high water level in Lake Pontchartrain, which bounds the city on its north side, has been effectively drained and is constantly maintained in a well drained condition, and the well populated area of the city, including about half the drained area and covering about 600 miles of streets, has been fully served with water and sewerage facilities, and has had practically all of the premises therein connected with both water and sewerage systems and provided with modern plumbing facilities, even the plumbing inspection of which has been under the jurisdiction of the Sewerage and Water Board.

Death Rate Decreases One-Third

With these developments, and made possible in large degree only by them, the total death rate of the city has decreased about one-third. Malaria has practically been eliminated and the whole general aspect and sanitary and living conditions of the city have been so improved that New Orleans today ranks with the best cities of the country in all of these respects.

In all three systems most unusual problems were presented, and experience elsewhere was not a safe guide in overcoming local conditions. Due to the unification of management and the continuous opportunity for gradual development and because men in various departments of the Board's service were given opportunity to exercise initiative, and, where necessary, disregard precedent and ordinary procedure in the conduct of their work, there have been many innovations and improvements over usual methods and procedure effected and much most useful information collected.

Many Innovations and Improvements Effected

The annual reports of the Board have treated of these from year to year but a brief review of some of the more important of these things may be of interest.

Soil Vibration and Surface Settlement

One of the problems which most seriously affects all underground and surface structures in New Orleans has to do with vibration and surface settlement. Saturated clay is subject to very great shrinkage as its saturation is reduced, and roots, stumps and peaty formations to even greater shrinkage. As a result, irregular surface settlement occurs in newly drained areas which were originally at or near gulf level, and structures resting on the earth with shallow foundations have a decreasing amount of settlement as the depth of their foundations increase. This causes manholes, and other appendages to underground structures which extend to the surface, gradually to raise above paved surfaces; to cause drainage openings that were set in surface depressions to become, instead, high spots; to throw irregular settlement strains into shallow water mains, and to do unspeakable things to surface pavements and the line, grade and joints of street railways. In certain areas, vibration, due to ordinary street traffic where heavily loaded trucks of certain objectionable character are used, is seriously felt in the lead joints of water mains; and nearly everywhere in the city steam railroads passing over water mains tend to cause leakage by vibration.

Even in the layout of the drainage systems and the lifts required at drainage pumping stations the necessity to remove the water from distant low areas, a foot or two lower than they were originally, must be taken into consideration.

Again, the system of bench marks from which all construction is built and extended itself constitutes a perpetual problem, and must be constantly checked up from certain pile supported structures which themselves are not too heavily loaded.

Unusual Rainfall Produces Special Pumping Problems

One of the greatest problems in New Orleans has been to take care of the pumping necessitated by the rather unusual rainfall. This combined with the flat topograph and the large area to be drained has presented very serious difficulties.

Rainfall

In 1895 when the drainage problem was first being studied six recording rain guages were placed in various portions of the city. These guages have been maintained ever since and they afford most interesting and valuable data.

The following tabulation of monthly and annual maximum, minimum and average rainfalls for this 24 year period is interesting.

	Maximum	Minimum	Average
January	7.65	0.75	3.47
February	13.27	1.29	4.58
March	11.77	1.23	4.37
April	12.64	0.66	4.71
May	13.98	0.10	4.09
June	10.48	1.21	5.19
July	10.93	2.51	6.20
August	9.21	3.01	5.55
September	16.01	0.39	5.29
October	12.14	0.60	2.95
November	6.32	0.21	2.38
December	13.18	1.62	4.90
Per annum	74.68	33.51	53.82

Far more interesting and useful, however, is the following tabulation which indicates the maximum amount of rainfall to be expected in New Orleans within any given time interval and approximates the average annual maximum amount for the same time interval.

Rainfall Intensities

Based on rainfall records from six automatic guages at New Orleans for 24 years, from 1895 to 1918 inclusive, the maximum amounts of rainfall which have occurred within given time intervals are as per column No. 1, and the approximate average of the maximum amounts for each year for the same time intervals are as per column No. 2.

Time Interval	Column No. 1	Column No. 2
3 Consecutive minutes	0.63	0.33
5 Consecutive minutes	0.83	0.47
15 Consecutive minutes	1.73	0.87
30 Consecutive minutes	2.63	1.48
45 Consecutive minutes	2.99	1.70
1 Hour	3.52	1.78
2 Consecutive hours	4.64	2.30
3 Consecutive hours	5.80	2.78
4 Consecutive hours	6.17	2.98
5 Consecutive hours	7.03	3.20
10 Consecutive hours	7.60	3.90
15½ Consecutive hours	9.21	4.30
15 Consecutive days	22.24	5.00
30 Consecutive days	23.00	7.00
1 Calendar month	16.01	6.20
2 Consecutive calendar months	26.62	11.75
3 Consecutive calendar months	30.81	17.04
4 Consecutive calendar months	36.48	22.23
5 Consecutive calendar months	41.75	26.32
6 Consecutive calendar months	47.06	31.03
1 Calendar year	74.68	53.82

Platted up to the 15 hour period column No. 1 above makes a reasonably regular curve. Until Oct. 29, 1918, it was badly "broken hacked" at the one hour period with a 2.8-in. maximum. The 3.52-in. above recorded for one hour is from a perfect and fully checked automatic record of a rain so steady that it did not crowd the record sheet at any point and was below several other recorded rates up to the 30-in. period, and in fact, did not impress one at all as a very unusual rainfall either on the record sheet or in observation of the rain as it fell.

Drainage Pumping Stations

There are seven pumping stations serving the drainage system, with an aggregate capacity of about 7,000,000,000 gals. per day. Much of the drainage has to be pumped twice, and sometimes part of it has to be pumped four times. Pumping stations which deliver into the high level outfall canals have to lift the water 6 to 14 ft. and those making an intermediate lift have to lift it anywhere from 2½ to 9 ft., usually the lower the lift required the more imminent is the need for efficient pumping.

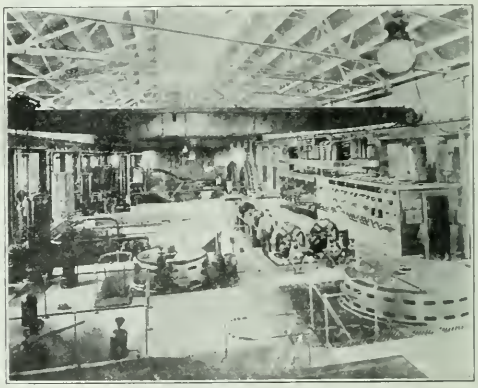
When a considerable rainfall occurs the various pumping stations will begin to get its full effect in from 15 minutes to 1 hour and 30 minutes after the rain begins. During this interval, steam must be raised or increased, electric generators started, and enough pumps gotten into operation to pump the water which arrives at each pumping station just as fast as it becomes available for pumping.

Ordinary Pumping Facilities Insufficient

The actual time interval between an empty drain on the suction side of a drainage station and a drain filled to its flood slope and ready to begin to retard the flow behind it, or even to overflow the surface of the ground at the pumping station is often only a very few minutes and when the drain delivery capacity to a pumping station is anywhere from 1,000 to 2,500 cu. ft. per second it is vital to be able to start enough pumping units within this short interval, and equally vital that these units be capable of doing efficient work in the conversion of power into water lifted throughout the extreme range of lifts required, with screw pumps of 250 cu. ft. per second capacity capable of a 54% efficiency at a 5 ft. lift and dropping to about 30% at a 2 ft. or an 8 ft. lift at the intermediate lift stations, and with centrifugal pumps of say 300 cu. ft. per second capacity, capable of 68% efficiency at an 11 ft. lift but only of say 40% at a 4 or a 13 ft. lift, these conditions could not be satisfactorily met. Too many units were required, and too large a proportion of their work was at lifts too far from that at which these units could work efficiently. Further, most of the original pumps were set down in pits to avoid the necessity of priming and operated by motors placed over them on vertical shafts. This necessitated very large gates and check gates to prevent back flow if the motors went out of step and made the whole outfit very difficult of access for maintenance and repair. With this experience in view it was determined when large increases in pumping capacity were undertaking to build the largest possible units, to make them accessible for painting, repair and maintenance from the end of their suction to the end of their discharge, to avoid all gates or check gates, and to seek if possible, a form of pump capable of reasonably efficient work for the full range of lift required.

Screw Pumps at Syphon Summits

To meet these conditions, screw type pumps were designed to be set in at the summits of a syphon passing over a wall which constituted the division between the suction and discharge side of the pumps. Eleven of these have been built and put into operation. They were designed under the immediate direction of Mr. A. B. Wood, Mechanical Engineer for the Sewerage and Water Board. They were built by the



INTERIOR VIEW OF DRAINAGE STATION NO. 1. NEW ORLEANS, LA.

Nordberg Engine Co. of Milwaukee, under a contract which did not even guarantee that they would pump water at all. Their capacity, depending upon lift, ranges from 400 to 700 cu. ft. per second, their efficiency at best point approximates 80% on lifts measured accurately from suction basin to discharge basin and quantities measured in a flume under excellent conditions for accuracy, and they show a very flat efficiency curve. These pumps are 12 ft. in diameter on the discharge side of their runners. They are provided with an automatic arrangement for freeing the blades of any trash which might otherwise interfere with their efficiency. They are operated by synchronous motors at a speed of 75 revolution per minute at the intermediate lift stations and of 83 1-3 revolutions per minute at the final discharge stations, and in both cases they have proven themselves able to cover the entire range of lift required without falling below 60% efficiency either at the lowest or highest lifts.

Special Screw Pumps Highly Satisfactory

Their cost to the Sewerage and Water Board per unit of capacity has been much less than that of former installations and every advantage which we had expected in economy and efficiency of operation has been fully realized. Rotrex Vacuum pumps of large capacity are used for priming these pumps, as soon as the water covers their suction and discharge ends they can be partially primed. When the water rises high enough to warrant the starting of a pump, the throwing of the switch starts the motor in the empty case and a little more priming brings the water high enough on the pump blades to start the full flow which, however, comes on

slowly enough to avoid stalling the synchronous motors. In case of any failure of power the vacuum is automatically broken and there is no back flow through the pump casing and, therefore, no necessity for large check gates or any other form of gates.

The difficulty and costs avoided by pumps set up in this way we have found to over balance many times the single added difficulty of priming, and the completed installation of eleven of these new large units at six of the main drainage stations has shown most magnificent results in every respect.

Sewage Pumping Problems

In sewage pumping, problems of a different nature but equally vital to the maintenance of economical and satisfactory operating conditions have arisen. The capacity of the main trunk sewer line and of the original force main from the central sewage pumping station to the river were over-taxed at times for short intervals much sooner than had been expected, because the fact of the increased porosity of the soil due to shrinkage following drainage had not been fully realized.

Effect of Soil Peculiarities on Sewage Pumping

The soil of New Orleans when saturated in its original condition passes water only very slowly; frequently excavations in continuous execution required no pumping at all, although they would gradually fill with water to very nearly the surface if left standing open for a few days. With the soil in this condition seepage or ground water finding its way to sewers would be nearly a constant small amount, and it had been estimated that about one-third of the total rainfall going off as a nearly constant flow would have to be handled through the sewers. Following effective surface drainage through main drains of considerable depth to prevent long standing surface saturation, and effective underdrainage by the sewers, the whole nature of this soil is changed; it has become extremely porous, and during long dry spells exposed soil surfaces crack open with deep cracks, and as a result rains, especially those following long dry spells, find ready access to the separate system of sewers, with the result that at such times the sewers are heavily taxed with seepage water flow.

The main sewer, which still serves the major portion of the city, the main pumping station and the existing 48 in. force main through which its flow is forced 7,000 ft. to the Mississippi river, could only be designed, with resources available, to take care of the needs of the early future, with additional intercepters, force mains and pumps called for in future extensions to be constructed as population, area covered, and run off required.

To keep up with the original intention one large intercepting sewer, one additional 48 in. cast iron discharge main, and another large pump were due to be built several years ago, not because the dry weather flow had reached the capacity of the system originally provided but because the occasional flow following certain heavy rains derived from a very large area was greater than this capacity.

Electrical Substituted for Steam Pumping

With the financial limitations existing it barely seemed wise, in the face of other more pressing needs, to invest in the extensions which the original plan called for, and the emergency was met initially by providing one new electrically-driven, two-speed centrifugal pump at the central sewage pumping station capable of delivering from 37 to 57 million gallons daily at 43 to 35 ft. lifts, with efficiencies ranging from 69% to 83% at 248 r.p.m. or of delivering from 70 to 88 million gallons daily at 87 to 72 ft. lifts with efficiencies ranging from 80% to 84%, thus doubling the quantity of flow which the existing 48 in. force main can take care of. This substituted electrical for steam operation of the central sewage pumping station, greatly reducing the force of attendants required and permitted the removal of the major portion of its boiler capacity and part of its electric generator capacity to the water works plant where it has been found best to centralize the main power system, and, despite the additional lift upon infrequent occasions, has actually resulted in reduced fuel consumption per unit of sewage discharged.

Intermediate Lift Sewage Pumping Stations

Part of the problem of sewage pumping and disposal, however, was at intermediate lift pumping stations at the other end of the main sewer lines which delivered the sewage by gravity to the central sewage pumping station. These stations now serve an area over twice as large as was originally intended for delivery through the existing main sewer. Only a fraction of the pumping capacity ultimately intended at each of these stations was originally installed.

The effort to operate seven pumping stations each serving a large area with its pumps automatically stopped and started and without any screening of the sewage was rather bold in 1900 when it was proposed. A great deal of study was given to the original design for these small stations, and pumps of the most open type to permit the passage of anything that might enter them were called for; in fact the specification that the pumps should pass a 3-in. ball caused protest by the contractor and very low guarantees as to efficiency. These stations went into operation in 1906-1907, and at first gave perfectly satisfactory results, because the main flow through the sewers was a ground water flow.

Rags Obstruct Pumps

As connections were increased one trouble began to manifest itself, viz, rags. Stopping and starting at predetermined levels on the suction side of the stations was always reliable, but with increasing connections and increasing flow the obstruction of the pumps by rags became a more and more serious matter, first decreasing the efficiency of the pumps and requiring the occasional opening of manhole plates for the removal of a few rags, and progressing until it became necessary to visit these stations two or three times a day for the removal of rags from the pump runners, and even then the accumulation was so rapid that the pumps never operated at capacity and the sewers were not being pumped out low enough to obtain grade line flow conditions. To abandon automatic operation without screening for seven stations and eventually for some 20 relifting stations that will be required to serve the developing area of New Orleans would necessitate the employment of 21 additional attendants plus a screening removal service now, and eventually of 60 additional attendants, or an annual expenditure now of about $35,000 and eventually of $95,000, all because people will throw rags into their toilets, although it is against the law to do so, and centrifugal or other electrically operated pumps cannot operate efficiently or to capacity with rags or similar matter which can be collected and hang on their blades.

Pumps Designed to Pass Anything Entering Them

Automatic arrangements for cleaning the blades of the pumps or for collecting screenings before the sewage entered the pumps were carefully considered but did not seem to give a reasonable hope of relief. We could see nothing short of passing the sewage as freely and as safely through the pumps as it passes through the sewer itself that would satisfy the requirements of automatically operated relifting sewage pumping stations. Initial pump efficiency might go to anything and still give a higher actual operating efficiency than rag obstructed pumps would give and save so much in cost of attendance and screenings removal as to make a pump that would pass anything which could enter it a paragon of economy. The writer had for years the belief that a bent T as a pump runner would pump water and pass anything that could enter it, and Mr. A. B. Wood, who is directly in charge of the Board's sewerage and water works pumping systems, undertook to design enough efficiency into something that could

not be obstructed to warrant its use. His studies indicated something better than 60% efficiency for a runner and pump that looked on paper as though it could not be obstructed by anything that could possibly enter it, and pump casings and motors enough to cover the needs of all of the existing intermediate lift stations were ordered, fortunately before war prices had become effective.

Characteristics of Special Obstruction-Proof Pumps

The runners were cast in a local foundry and finished in the Sewerage and Water Board shops, and most of these relifting stations, especially the larger ones, are now operating with these new pumps. Some of them have been in operation over two years; they show an efficiency of about 70%, with most desirable characteristics, and are not in the least affected in capacity or efficiency by anything that can enter them. The sewage enters each pump suction through a 24 in. pipe, reducing to 12 in. at the entrance and exit of the pump, and a 12 in. ball, or an indefinite amount of anything that could pass a well rounded 12 in. T, passes these pumps without the least trouble. These stations therefore are now just a part of the run of the sewer. A daily visit to each of them is a precaution and by no means a necessity.

At Flood Periods Sewage Pumped to Drainage Canals

Another automatic feature, however, has been added. These stations, as before stated, are serving areas twice as large as the system into which they discharge was intended eventually to serve, and when great rains occur they are delivering more water to the sewers than these areas will yield when they are fully provided with local drains and paved streets, and are far more densely populated, being a much greater flow than the main brick sewer and central pumping station can take care of. This delivery is of highly diluted sewage made at a time when the main drainage canals are themselves rivers of considerable magnitude; at such times delivery of this sewage into the large masonry lined and covered drainage canals is unobjectionable, and is the only way possible to continue to render service. Connections, therefore, from the discharge side of these pumping stations to the nearest main drainage canals, usually only a block or two away, have been made, and automatic arrangements provided whereby the opening to the discharge sewer is closed and to the nearest drainage canal is opened when the discharge sewer is overcharged to any adjustable predetermined elevation, and this condition is reversed when the level of the water has fallen to another adjustable predetermined lower elevation in the discharge sewer.

This is the reverse of a procedure which has been in effect for some years, viz, the discharge of the dry weather flow from the main drainage canal, serving the central section of the city, into the main sewer so long as the main sewer has capacity to receive it by an automatically operated gate in a connecting passage between the sewer and this main drain. Both procedures are equally logical and beneficial. Small amounts of drainage and street washings became septic in the very large lateral drains of the storm drainage system, which cannot possibly be maintained free from obstruction of sand, etc., and can only be adequately flushed by great storms, and the dry weather drainage flow from some areas is therefore more objectionable than sewage promptly collected in separate sewers which fit their work and are maintained always clean and unobstructed.

It is further true that in transit through the large masonry lined drainage canals even the dry weather flow accumulated from one of the sewage relifting stations is adequate to maintain good flow conditions, and would be no more objectionable and probably better combined with the accumulated dry weather flow from the lateral drains than the last named flow alone.

Probable Deviation From Original Plans

It seems more than probable, therefore, that the ultimate development in New Orleans will depart somewhat from the original intention, and that economy in ultimate first cost and more prompt and effective service with both systems will result.

The original intention was a strictly separate system of sewers discharging through pumps and force mains into the Mississippi river, and another entirely separate system of surface drainage discharging its dry weather and small storm flow through pumps into Bayou Bienvenue leading to Lake Borgne some 16 miles eastward of the city, and the excess water from the larger storms through pumps into Lake Pontchartrain on the northern boundary of the city. This requires for the sewerage many miles of trunk line sewers connecting between relifting stations and large force mains discharging into the Mississippi river which can be omitted if the proper masonry lined main drains can be constructed ahead of the sewers, and the sewage relifting stations can discharge into these main drains, all of which deliver toward Bayou Bienvenue and Lake Borgne, leaving it to the future to decide how much, if any, of the combined dry weather flow from the local lateral drains and the sewers shall be delivered through a force main at a high lift into the Mississippi river, or whether

DISCHARGE FROM ONE WOOD PUMP AT DRAINAGE PUMPING STATION NO 1, NEW ORLEANS, LA.

some additional flushing flow shall be furnished and the whole be sent at a low lift into the tidal Bayou Bienvenue.

The effect of the main drainage of an area of some 30,000 acres capable of carrying over 1,200 miles of streets, and the tendency for population to spread out over this vast area and demand for a widely scattered population the same facilities which already exist over 600 miles of streets covering half of the area and itself not fully populated, and accommodating 95% of the present population of the city, is creating most serious problems in connection with the sewerage, water and local drainage service to these sparsely settled areas.

Financing Improvements

New Orleans has arranged for the building of its sewerage and water works system, including connections to the property line and the main drainage system, from the proceeds of a tax levied equally against the assessed values of all property within the city limits whether said property gets any benefit from said systems or not, and as soon as the main drainage system converts a tide level swamp into drained land someone starts an addition to the city and wants sewerage and water extensions because he is paying the sewerage, water and drainage tax. The fact that his land has any value at all because it already has drainage and that the expenditure to give drainage has been far more than the tax derived from his particular area warrants, impresses him not at all.

Illogical Demands for Extensions

The writer has long advocated the idea, expressed by the homely proverb that "every tub should stand on its own bottom"—in other words that "every item of service of any kind should be paid for at its approximate cost by the party for whom it is performed." If the geenral tax for these three systems were separated and only applied to property benefited by them, and if it were only adequate to cover these portions of the systems of general applicability leaving to each property to pay a fixed average cost for sewer connections and for water meters and connections of various sizes, and a cost per square foot for water main extensions and sewer extensions and lateral drainage extensions, it would do a great deal to prevent illogical demands for such extensions, and to force the city growth to conform to such logical and continuous extension from well defined centers that the financial ability of the city could keep pace with the requirements and maintain these services effective to the whole of the population all the time.

Unused land held at high prices in desirable areas and depreciating ill-kept and often unoccupied premises in other areas, all of which are already fully served with adequate sanitary facilitis, are in large part the cause and in still greater degree the result of the too rapid extension of the suburbs.

Injustice to Majority

It should be obvious that the first cost of sanitary improvements, of transportation, of lighting, and in fact of all public service facilities as well as the cost of their maintenance and operation, must be proportionately greater for a given number of population as the mileage of streets over which these services must be extended to serve said population increases, and it is most unfair if the vast majority of the population of a city must suffer in the character of service given or has to pay rates and taxes far in excess of the cost of these services for them in order that an insignificant minority may obtain equal service at a payment in rates or taxes far below the cost of the service which they receive or demand because the minority has chosen to buy and build over scattered lots in outlying areas.

Reinforcing the Systems

The New Orleans Sewerage and Water Board has gone as far as it can in extending the facilities over the widest possible area, and has now reached the point where in order to maintain the adequate service already given to 95% of the population who are now served, it must begin to strengthen its system in various ways by the addition of items which it would like to have included in its original construction, if more funds had been available, but the omission of which temporarily has not as yet caused any failure or trouble in a 10 year period of service while it has permitted a much wider area and larger population to receive the services than would otherwise be possible fully covering all of the well populated sections of the city and enough close in and as yet sparsely settled area to provide for a very considerable increase in population.

Automatic Operation

Because New Orleans has to depend upon pumping, with practically no reservoir capacity, in its sewerage, water and drainage system, there has been unusual need of automatic apparatus to govern levels or flows under various conditions, and a great deal of apparatus of this character has been employed, resulting in the development of a general system adaptable for the automatic regulation of one or more fluid pressures or flows in any desired relation with one or more other fluid pressures or flows.

Automatic Control in Water Filters

Upon this general system were first built the original variable-rate water filter controllers and proportional flow chemical rate controllers which have been in most satisfactory operation since their first try-out in 1909. Later, apparatus to regulate the rate of flow from the reserve supply clear water reservoirs, and other apparatus to open or close connections between the sewerage and drainage systems at many points depending upon any desired conditions of relative pressure in adjacent sewers and drains, has been added, and still later when liquid chlorine sterilization of the filtered water was undertaken as a final precaution, it was arranged to draw very small flows of water from the discharge side of each pump delivering water into the distribution system, said small flows bearing a constant and common ratio to the individual pump discharge, to add a proportional flow of chlorine gas to these combined withdrawn flows governing the chlorine flow after it leaves its original container at a constant pressure below atmospheric pressure to prevent chlorine leaks, and to reintroduce the chlorine solution thus made to the supply approaching the pump suctions. The withdrawn flow from each pump passed through an ordinary disk meter can integrate and record the work of each pump, and the combined withdrawn flows passed through a similar meter can integrate and record the total delivery of water into the distribution system. Similar apparatus introducing a very small proportional flow of clear water into the 48 in. discharge main leading from the main sewage pumping station and recording said introduced flow, and another governing the effluent flow from a filter and recording same on a 7 day chart, have also been installed.

Use of Equal Pressure Diaphragms

The introduction or withdrawal of a flow proportional to a varying rate of main flow, or the government of two flows to maintain them always proportional to one another, is effected in the more recent apparatus by what we call "equal pressure diaphragms" which are limber, light diaphragms that offer practically no resistance to motion in either direction for the full extent of motion required of them, the function performed by one of said diaphragms being in all cases to maintain either exactly the same pressure or a constant almost infinitely small amount more or less pressure on one side of said diaphragm than exists on its opposite side, through the action of a light balanced valve operated by the diaphragm and never required to effect a large amount of pressure absorption.

The first diaphragms of this character were put into operation over three years ago, have been in constant operation ever since without change or repair, and show no indication of trouble. Pressure regulation of this character with properly constructed apparatus is instant and exact, as though the governed and governing pressure were from a common source, and proportional flow or other operations depending upon it show wonderful consistency in every test which we have ever made.

Advantages of Proportional Flow Apparatus

It is well known that ordinary Venturi measurements can only cover a small range of flows between velocities too low to give sufficient differences of pressure for accurate indication or integration through apparatus operated directly by these small differences of pressure, and too high for permissible amounts of pressure absorption; we find proportional flows are practicable for much lower velocities than pressure difference apparatus. Further, with proportional flow apparatus, individual main flows like filter effluents or pump suctions or discharges, etc., which have each usually a relatively small range can be individually paralleled through restrictions in pipe lines carrying them which can be made to give ample differences in velocity to provide proportional flows to each of said main flows for such small ranges of flow, so that the utilization of restriction of small extent required often for other uses, or immaterial in their pressure absorption at maximum rates of flow, can be made to give proportional flows bearing a common constant ratio to a plurality of main flows, and the measurement, either at their source or outlet, of these combined proportional flows provides for the measure-

ment of the combined flows without squeezing the combined main flows through other special pressure absorption apparatus for such measurement.

Use of Recording Apparatus to be Extended

A 1 in. disk water meter can be made to give accurate integration for a range of flow of from say ¼ gal. to 30 gals. per minute, and to record these rates of flow as actual flows on a clock driven drum carrying a 7-day chart, in other words can record for a range of flows from 1 to 120, and could, therefore, if desired, record the summation of flows through 20 pipe lines either of which had an extreme range of flow through it of from 1 to 6. We believe that a recording apparatus in which a single 7-day chart can tell an observer accurately whether the output of a plant was 1 or 50 or 120 million gals. in 24 hours, or 3,500 or 175,000 or 420,000 gals. in any given 5 minute interval up to the instant position of the recording pen is far more worth the cost of installation plus the cost of charts and time for their placement and removal, and expect gradually to add to the recording apparatus of this type already installed, at least enough to get accurate data as to the run off from some of the automatically operated sewage pumping stations. Similar recording of some of the drainage stations would be of very great value, but unfortunately the original pumps installed at these drainage stations are submerged, with suction and discharge lines buried in masonry and not properly formed to give any pressure difference which would afford a reasonably accurate function of their flow.

It would therefore only be practicable to record the flow through the new pumps, the output of the old pumps being calculated or estimated from station records taken when the operating forces are far more interested in getting water moved than in getting accurate records of the time of starting and stopping pumps, water levels, etc., etc., from which data the portion of the station output due to the older pumps would have to be estimated. Partial records that must be calculated or corrected by other records are usually never so calculated or corrected and are of very doubtful value. For a complete new plant we would expect to include recording apparatus that would give total station output whether it be in gallons of filter effluent or water pumped, or pounds of gas in a gas flow, or heat units above a fixed temperature in a steam flow, by the proper utilization of proportional flow apparatus.

Large Water Meters

Tests and early experience with large water meters led to the development of a special type of large meter for the Board's use, and since about 1911 the Sewerage and Water Board has bought no water meters larger than 2 ins. This meter consists first of a main check gate which is held closed by a small piston, upon one side of which the pressure on the discharge side of the check gate is effective, the opposite side of said piston being at atmospheric pressure. Around this check gate are two small metered by-passes, each controlling by Corliss Valve Outlets operated by the main valve, and in its axle the one open when the main valve is closed, and entirely closed, the instant the main valve starts to open, and the other opening in proportion to the opening of the main valve. This form of meter is applicable to every use, it gives correct registration on all flow from the smallest which can be accurately registered by a small disk meter in the first named by-pass, i.e., a small fraction of a gallon per minute, up to the full capacity of the pipe line upon which it is placed, maintaining always a sufficient difference of pressure (or pressure absorption) at the main valve for accurate measurement, but opening the main valve more and more as the draft increases to avoid any greater pressure absorption. No strainer or trap of any kind is used ahead of the main valve which is designed to pass anything that can reach it up to a ball of its full diameter, an annular screen of large area protects the pressure chamber which supplies the two small meters. Over 200 meters of this type made in the Sewerage and Water Board shops are now in use. These mostly have either 4 in. or 6 in. main valves, and, depending upon maximum rates of flow desired, 4 in. main valves are used for services from 4 ins. to 8 ins. in diameter, and 6 in. for services from 6 to 12 ins. in diameter.

A 6 in. main valve with gradual reducers leading to it and increasers leading from it when called upon to deliver very large flows through a 12 in. main amounts in effect practically to a 6 in. throat in a 12 in. Venturi.

Measured in pressure absorption at all flows up to maximum delivery capacity, in accuracy of record at all rates of flow from any leak which even a small disk meter can record to maximum rates, in certainty of delivery, in freedom from trouble of any kind, in accessibility for repair in place without shutting off supply from premises, and in applicabillty to every form of service, from fire connections using no water to railroad stand pipes which have very large consumption with most difficult water hammer conditions, experience since 1911 with this type of meter in New Orleans has more than warranted its development.

Probable Unrecorded Flow Through Small Meters

One of the considerations which have impressed itself upon the writer in connection with fully metered water supplies is the fact that there is a certain rate of small flow due to leakage which no meter can record. A ⅝ in. disk meter in New Orleans is purchased under specifications requiring at least 90% registration at 1-6 gal. per minute flow, and at leaest 97% registration at 1-3 gal. per minute flow. At flows much below 1-6 gal. per minute most ⅝ in. meters will not register at all, and with the least swelling of disk or sticking anywhere they will fail to register at much larger flows, sometimes up to ½ gal. per minute. Even at 1-14 gal. per minute of constant leakage flow there is an unrecorded waste of 100 gals. per day and since the average meter record per connection in New Orleans indicates less than 200 gals. of use per day per house it is obvious that there could be a constant leakage of 100 gals. per house unrecorded as against this 200 gals. of recorded consumption, or 50% under registration on the small consumer flow. When the length of pipe lines, the number of joints and openings and particularly the usual character of closet flushing tanks which have an outlet valve which must seat under only a few inches of water pressure and be maintained perfectly water-tight to avoid small leakage, are all taken into consideration, is it not probable that the differences which are found between metered supply into fully metered distribution systems and metered consumption therefrom, are far more to be attributed to meter under-registration due to very small leaks inside of consumer's premises than is usually assumed? The writer believes that even when all services are metered, as they undoubtedly should be, the character of plumbing inside of consumer's premises is still of very great importance in its bearing upon water consump-

EXTERIOR VIEW OF POWER AND PUMPING STATION AT MAIN WATER PURIFICATION PLANT, NEW ORLEANS, LA.

tion. Leaks start too small to record on the meter, and until they are reflected in the consumer's bill for water they are not repaired. Often, many small leaks are most difficult to discover at all, and cannot possibly attract notice. If the average meter in New Orleans has an unrecorded flow of 1/14 gal. per minute or 100 gals. per day it means 5,500,000 gals. per day of under recording of flow or about 1/6 of the total amount of water supplied to the distribution system.

Simple Apparatus to Determine Rate of Small Leakage Flows

The writer has made considerable study to find a way to determine the existence and rate of very small leakage flows, and has suggested a simple apparatus with which it is intended to test a lot of representative premises during times of supposedly zero consumption, which can be placed at any water connection and connected into the space usually occupied by the meter, the meter itself may be connected into the apparatus, and by its use the recording accuracy of the meter at all rates of flow can be determined, and in addition flows escaping toward the premises no matter how small can be read by an observer.

Troubles With Contractors

The earlier construction works of these three systems were erected under contracts of the usual form often including guarantees of efficiency or of results otherwise, and allowing more or less discretion in design of machinery or in method of conduct of other work on the part of the contractor.

The law requires the Sewerage and Water Board to let its contracts to the lowest bidder on any given plans and specifications, leaving no discretions, and more or less of the usual troubles followed these usual forms of contracts.

The contractors during construction often claim that they must have their own way in all things if their guarantees are to hold and after construction, if their guarantees are not met, that conditions over which they had no control were responsible. As a result of this, and especially of high bids, which were rejected on a lot of sewer contracts in 1907, the Sewerage and Water Board concluded itself to assume full authority and responsibility and subsequently has executed much of its work under the direct supervision of its own forces eliminating any general contractor.

Day Labor Plan Successfully Employed

All sewerage extensions since 1907, and all water extensions since 1908, as well as all house connection to both systems and many other things, have been done in this way with very great saving in cost and material improvement in the character of the work or results otherwise procured. This would not have been possible when these works were started, but with the building up of the Board's forces through experience and continuous employment in special lines of work, these forces are now far better qualified to design and direct its work in most directions than any contractor less familiar with local conditions.

All Water Services Are Metered

In the operation of the water works system which was started in February, 1909, it was clearly indicated within the first six months that without water meters consumption would go beyond the capacity of the plant before all of the premises of the city were connected with the system and the all-meter system was at once adopted, and by the end of 1910 practically all water connections were metered with the result that the system after ten years is still reasonably ahead of the consumption demand in its capacity.

Meter Rate

In adopting the all-meter system, a meter rate had to be worked out, and after much study of existing rates what is termined a "service charge" in contradistinction to the then well known "ready to serve charge" was adopted, being a definite amount for each size of meter and connection enough to cover the cost of maintaining the service line and meter, and the cost of meter reading, collection, accounting and inspection inside of the consumer's premises; in other words, enough to cover all costs arising from the consumer's tap in the main to the delivery of water to him, and a uniform price was set for water recorded through the consumer's meter, enough to cover all costs arising on the city side of the consumer's tap in the main and fairly chargeable to the "used" capacity of the plant. Leaving the unused or surplus capacity available for fire protection and future growth to be paid for by the tax payers. This system encourages legitimate consumption and discourages waste offering the same incentive to every water consumer to use or save a given amount of water.

There were, as frequently happens, restrictions of various characters in the law creating the Sewerage and Water Board which had to be regarded not only in rate making but in many other respects which are highly objectionable. The method of rate making proposed for New Orleans included an accounting system which would determine the average cost of the various items of service rendered, and proposed from time to time to adjust rates charged to beneficiaries for these items, to meet the varying conditions of cost under which the system had to be operated. This was practicable under the original law which stipulated what costs were to be paid for out of water rates, and what out of taxes, and limited the rates to those that would meet the stipulated costs. Having made rates to meet these certain stipulated costs and lowered these rates until they were barely safe to meet the costs for 1914 conditions, the law was changed so that a large amount of other costs should also be met from these rates, but stipulated that these rates should not be increased beyond those then existing. When war prices and conditions for material and labor were added to this condition it rendered the situation exceedingly difficult.

Service Must be Paid For

The cost of all service must be met somehow, or it will cease to exist. When the water rate payer gets his items of service below this cost, the tax payer usually has to pay the bill in some other form and if the tax payer evades his fair share then some items paid by some rate payer must bear the additional burden. When everyone reaches the conclusion that it is better and fairer for every beneficiary of every service to pay the cost plus a reasonable margin on all of the items of service which he receives, rather than to spend his time in fighting to unload his fair proportion of charges upon someone else's shoulders, thus saving also the time required on the part of the other fellow fighting back, there will be a lot of wasted time and effort saved and available to increase the total amount of all service which all of us can render, which, after all, is the measure of all of the service which all of us can receive.

Organization and Personnel

The organization of the Sewerage and Water Board forces has been worked out not as separate organizations for each of the three systems but rather with a view of obtaining the maximum of efficiency for the service as a whole, and of delegating to each separate department that work which its head and organization can best perform.

Drainage Canals

The maintenance and extension of the main drainage canals and their laterals is under Mr. Alfred Theard. Mr. Theard has been associated with the drainage work from its inception in 1895, in a responsible capacity, was familiar with the rainfall and run-off studies from the start, and responsible for the evolution of the Drainage Collection System which is so successfully meeting the very difficult local drainage requirements.

Water and Sewer Lines

The maintenance and extension of the Sewage Collection and Water Distribution Systems and Connections is under

Mr. John T. Eastwood, who started on the design of these systems in 1900 and has been continuously employed, first on plans and estimates, then in construction merging into maintenance and extension. His interest in his work and his industry and good judgment coupled with his continuous experience in the construction and maintenance of these systems has pulled them through the first ten years of their operation with a spendid record, far better than could have followed under less competent management. With 1,100 miles of water mains and sewers and about 55,000 connections serving 76,000 premises from the mains to the property line on each of these systems, and with 500 miles of storm drains besides extensions always in progress on all three systems, automobile and team and truck service and the maintenance of a central yard for supplies of all kinds and for general repair work is a most important feature.

Central Supply Yard

This yard is operated under the Sewer and Water Maintenance Department, with repair shops, stables, garages, warehouses, track connections and large storage spaces, with locomotive crane for loading, unloading and handling, and with the necessary accounting and checking system and serves all of the above named work, and other departments when called upon, and is far more complete and useful to the work as a whole, and can afford, and be more interesting to, a more competent superintendent in charge, than would be possible if each system had to depend upon its own yard and shop facilities.

Drainage, Pumping and Power Stations

The maintenance and operation and extension of the seven large drainage pumping stations and the power station and transmission lines for their operation is under Mr. Alfred Raymond, who has filled the position since the original installation of this system, and also cooperated most helpfully with other departments of the Sewerage and Water Board service and of the city in his capacity as an electrical engineer. These stations are widely scattered, and several of them relatively inaccessible. Their upkeep is an important factor and they are all provided with a fair equipment of machine tools to permit the regular forces employed in their operation to take care of all ordinary repair work.

Water, Sewage and Power Stations

The maintenance and operation and extension of the water and sewage pumping and power station is under Mr. A. B. Wood, who started under Mr. Raymond at the inception of the drainage service and during the construction of the water and sewerage systems was assigned as mechanical engineer to this service. In the development of the systems it has gradually come about that there is an interchange of power and a complete cooperation in every way between the sewerage and water and the drainage power and pumping systems and the heads of the two departments have worked together in the development of most important improvements in the pumping and power systems which have been in progress during the last several years.

Machine Shop

At the water works pumping station a well equipped machine shop is maintained at which all major repairs on mechanical work are executed and much new work, including smaller pumps and large water meters and much other special apparatus is built. All meter testing and repair is also carried on under this department, at the main water purification and pumping station.

Water Purification

The maintenance operation and extension of the water purification system is under the direction of Mr. John L. Porter, director, who entered the board's service as a sanitary engineer in 1900, took part in the original water purification investigation and thereafter maintained a laboratory for continuous study of the water purification problem and for all cement and other testing, required in large amount, in connection with all departments of the Board's service. Mr. Porter also co-operated in the framing of plumbing regulations and organized the plumbing inspection department taking charge of this work until the water purification system was ready to go into operation, when the plumbing inspection department was turned over to Mr. Geo. A. Middlemiss, who had been an assistant engineer on drainage, sewerage or water works construction from the inception of the drainage work. At the main water purification station a well equipped laboratory is maintained, and all testing work requiring its facilities is taken care of there for all departments of the service.

Reservoir System

Under local soil conditions the maintenance of the rather extensive reservoir system required for the proper preliminary treatment of the Mississippi river water is of itself no small task, and the fact that the first tryout of the New Orleans water purification system was the beginning of a period of continuous and highly successful operation of which there has been no cessation to this time is largely attributable to the foresight, skill and experience of the director of that system.

Accounting

The accounting and general business of the board as well as the water collecting and meter reading are under the direction of the secretary of the board, Mr. F. S. Shields, who has filled this position continuously since the first organization of the Sewerage and Water Board in 1900 and has commanded the confidence and esteem of the board itself and of all of the departments of its service, because he has been consistently cooperative and helpful in every possible direction.

The Sewerage and Water Board

The Sewerage and Water Board itself is composed of 13 members, seven appointed by the mayor of the city, who is ex-officio president of the board, for 14-year terms, from the seven municipal districts into which the city is divided, two of whom are ex-officio members due to their membership on the Board of Liquidation of the City Debt, and three of whom are ex-officio members due to their membership in the Commission Council of the city, the Commission Council and the mayor being elected on four year terms. With the above form of organization for the board itself, any rapid turn over in its membership or policy, even with rapidly changing municipal political conditions is unlikely. The present mayor, the Honorable Martin Behrman is now in the middle of his fourth 4-year term and has consistently supported the board, and cooperated with its departments, and the board, as a whole, has given every possible support and opportunity for the exercise of initiative, and therefore for the performance of the best possible work of which its various departments were capable. Under these favorable conditions the various departments, each having work of sufficient magnitude to command and retain the interest of men of high capacity have far more than justified themselves in the results achieved and have built up, not only at their heads, but also in charge of various sub-departments, and in lower positions, a force of men who are true to themselves, loyal to their work, and to one another and highly skilled in their special lines.

The writer of this article who has been the responsible engineering head of the board's organization for 19 years, believes that under a properly formed public board it requires only a little encouragement in right directions and discouragements in wrong directions, with full recognition everywhere of creditable work, to obtain individual interest and initiative, and to build up a strong, loyal, co-operative organization of this character, for any city, which could be trusted with any extent of responsibility in municipal public service work, and which would be more and more efficient as the responsibility thrust upon it and the authority delegated to it increased.

Public and Private Ownership

The contentions between cities and privately owned public service corporations and the misunderstandings and poor service which frequently result from the mutual effort to get the best of the bargain, are all tending toward public ownership, and such ownership will be a blessing or the reverse, depending first upon whether public management is conducted in the interest of the public as a whole by competent authorities, or is made the plaything of shifting political conditions, and second upon whether or not the public as a whole will tolerate the idea that all service must be paid for at its fair cost, that accounts must be so arranged that the average cost attributable to every item of service rendered, and aggregating the total cost of the whole service including interest and depreciation and every other cost, can be determined, and that the cost so determined, adjusted as required to meet changing conditions, plus a reasonable margin, shall be the price paid by every beneficiary for every item of service rendered. Probably no public service today nearly approximates this condition, and until every public service, in every item, is thus regarded and the nearest practicable approximation of this principal is effected, neither publicly owned nor privately owned public service corporations can render their best service or attain that position of stability in management and of universal public confidence which is essential to their most successful development.

Some Specific Suggestions on the Design and Construction of Modern Wood Block Pavements

By E. A. Fisher, City Engineer, Lakewood, Ohio.

The troubles of bleeding, buckling and decay of wood block paving have occupied the attention of paving engineers for some time. Expansion of the block under conditions of moisture has caused blow-ups, excessive bleeding, curbs pushed out of line and a rolling surface. The use of the old-fashioned sand cushion and sand filled joint has led to uneven surfaces due to shifting and shrinkage of the cushion, it has encouraged decay by providing the very condition best fitted to produce decay. The study of details connected with the above troubles has resulted in the development of a type of pavement designed to meet the objections to older methods of laying creosoted wood block.

The Modern Wood Block Pavement

The modern wood block pavement in its latest development consists of laying block on a pitch cushion applied to a smooth concrete base and filling part of the joint with pitch and the remainder with sand. This method has been followed in Europe but is relatively new to America.

The following are some practical considerations intimately connected with this type of pavement.

Pavement Base

There is a diversity of opinion as to the thickness of concrete base to be used under a given pavement. It is conceded that the load to be carried is the determining factor. It has been the writer's practice to lay no base of less depth than 6 in. for any street. For main thoroughfares with heavy traffic bases 8 to 10 in. in thickness, depending upon the load and soil conditions, are desirable. Since the foundation is really the life of the pavement, the added first cost of a thicker base on heavy traffic streets is money well invested.

The coarse aggregate should be carefully graded and the mortar content so figured as to give an overloading of the voids in the mixture of about 15 percent in order to furnish sufficient mortar to flush coat the top of the concrete. A sidewalk finish is obtained by the use of a roller 6 ft. long, 9 in. in diameter and weighing about 50 lbs. This roller is used transversely of the street after the concrete has been brought to the true contour. The effect of this rolling is to squeeze out the excess water in the surface of the concrete, level the surface and eliminate short waves so objectionable in any pavement. There is a slight tendency for the mortar to pick up behind the roller and leave small corrugations which are removed by floating with a long-handled float. One man can finish much faster than the concrete can be poured and a more efficient and cheaper method of bringing the concrete to a true surface would be hard to devise.

After finishing, the concrete is allowed to cure and set the specified number of days and when perfectly dry, the pitch coat is applied.

Pitch Coat

This pitch coat is a coal tar distillate whose melting point

VIEWS SHOWING CONSTRUCTION PROCEDURE ON MODERN CREOSOTED WOOD BLOCK PAVEMENTS.
Top Row: Pulling Strike Board on Concrete Base, Door St., Toledo-Concrete Roller in Use on Same Base. Bottom Row: Placing Pitch Cushion with Buckets and Squeegees, Superior Street Pavement, Toledo-Wood Blocks being Laid on Same Pitch Cushion.

is between 140 and 150 degrees F. The pitch is heated to a temperature of 250 to 350 degrees F., depending upon the weather and the state of dryness of the concrete, poured from buckets and spread to an even thickness of ⅛ in. with squeegees; care being taken not to overlap and produce uneven thickness of the coat.

The precautions to be taken are (1) to see that the pitch is of the proper melting point and answers the specifications when it is delivered on the work since the practice of keeping large quantities of pitch above the melting point for long periods has a tendency to raise the melting point and to produce too brittle a pitch; (2) to see that the pouring temperature is never below 250 degrees F. and high enough to insure its being workable when it comes in contact with the concrete; (3) to see that the pitch is uniformly distributed, since overlapping or uneven pitching will give trouble later in the rolling, especially if the weather is very cool; (4) to see that the concrete is as near absolutely free from dust as is possible. This may be accomplished by the use of street brooms followed by corn brooms in cool weather or by the use of water in warm weather. The impalpable dust on the top of concrete prevents the adherence of the pitch coat to the concrete.

Creosoted Wood Block Surface

After the pitch coat has cooled and within thirty minutes after applying, the creosoted wood blocks are laid directly on the pitch coat and rolled longitudinally and transversely with a 4 to 7 ton tandem roller. The rolling sets the blocks into the pitch and seals the bottom of the block against the entrance of moisture. Expansion is provided along the curb by an asphalt premolded strip of a thickness depending upon the width of the street.

As soon as the blocks are set and culled and rolled, the joints are filled to a depth of 1 in. with pitch having a melting point of 140 to 150 degrees F., after which sand is spread upon the street in an even layer to the depth of about 1 in. and left to be worn into the joints and into the top of the block by traffic. It has been suggested that it might be better to place ½ in. of sand in the bottom of the joint first and then pitch the joint, the argument being that with pitch on the bottom of the block and in the bottom of the joint that there might be a tendency for the block to float. The writer sees difficulty in getting ½ in. of sand uniformly in all joints and has not seen any blocks float after once having been pitched. The method of pitching the bottom of the joint and of setting the block on the cushion seals the bottom and four sides against the entrance of water at a place where it cannot readily evaporate.

Some practical considerations may not be amiss: (1) The main point to be watched in filling joints, after being assured that the pitch meets the specifications, is the temperature at which it is poured. This is really an important consideration. The writer feels that the proper temperature is between 300 and 350 degrees F. or even higher if the nature of the pitch will stand it. Any chilling, and therefore hardening, of the pitch before it is in its final position in the joint results in a waste of the material on the surface of the block and a gummy, disagreeable street in warm weather. (2) The pitch is poured from buckets onto the surface and squeegeed into the joints. If the joints are filled full on the first application and squeegeed, after settlement there will remain in the joint very uniformly the right amount of pitch, 1 in. for a 3½ in. block. (3) Particular care must be taken thoroughly to clean the surface of the blocks with the squeegee while the pitch is hot. A gummy street from pitching is inexcusable. (4) The sand to be used in filling the remainder of the joint should be clean, sharp and fine enough to flow into the joint.

Treatment of Block

The subject of the proper creosote oil to be used in treating timber for creosoted wood block is an open question and will not be discussed here but the method of treatment is, to the writer's mind, of extreme importance. The usual specification of so many pounds, usually 16, to the cubic foot of timber should carry with it an explicit statement of how the oil is to be applied. After specifying the kind of oil to be used and the temperature at application the modern specification requires pre-steaming at 220 to 240 degrees F. for from 2 to 4 hours, vacuum of 22 in. application of oil at a gradually increasing pressure to 50 lbs. at the end of the first hour, 100 lbs. at the end of the second hour, and not over 150 lbs. during the third hour or until the wood has absorbed the necessary or specified number of pounds of oil per cubic foot. This method is aimed at getting a thorough impregnation of the oil thruout the block. The manufacturer could get 16 lbs. of oil per cubic foot into the block in the first 30 minutes by stepping up the pressure a sufficient amount. After-steaming and vacuum will remove excess oil from near the surface and reduce the tendency to bleed.

Advantages of Lug Block

The writer prefers to use a block having separators or lugs to provide for expansion, space for joint filler, and to furnish foothold for horses and further reduce slipperiness. No doubt many blow-ups on otherwise good wood block streets are due to the lack of sufficient provision for expansion and the use of a separator or lug which will either crush into the side of the next block or be crushed itself seems a sensible and logical method of providing for expansion. It is imperative that the sand used in filling lug block pavement joints shall not contain pebbles so large as to destroy the effect of the lug by bridging from block to block.

The writer has seen wood block pavement laid on streets receiving little or no heavy traffic with results that were not creditable to this type of pavement. Creosoted wood block pavement is essentially a heavy traffic pavement and in addition to furnishing long wear under these conditions, it is sanitary, noiseless, does not reflect light or heat, does not originate dust and is less slippery than sheet asphalt. Its first cost is slightly less than other high class heavy traffic pavements of equal durability.

Summary

The modern creosoted wood block pavement consists of a sufficient concrete base finished to a sidewalk surface made free from undulations by the roller and float method of finishing; a pitch cushion which adheres to the block and seals the bottom against water; properly impregnated long leaf yellow pine block with lugs to take up expansion and prevent excessive bleeding; a pitch filler to one-third the depth of the block which further seals the block against water; the surface of the block cleaned of all pitch; clean, sharp sand in the remainder of the joint and proper expansion along the curb.

The Present Level of Prices, with Special Reference to the Prices of Road-Making Materials

By S. M. Williams, President Highway Industries Association, McKim Bldg., Washington, D. C., in addressing conference of Governors and Mayors at Washington, D. C., on March 5, 1919.

Much has been said during the last three days regarding the present situation concerning public work and especially road building. I would not attempt to argue for unreasonable prices because unreasonable prices cannot be maintained. I have even gone so far as to say definitely to the producers of road building materials that if they are not in a position to justify their prices and reductions are coming, they should be made immediately.

If war permitted an unusual profit in any commodity that margin of profit cannot and should not be continued, but if products only brought during the war a reasonable margin of profit, and in order to maintain that profit, present prices must be continued, it is the duty of you men to uphold them.

Suspicion of Prices

Unfortunately there is a very marked degree of suspicion in

the minds of the public. One industry is awaiting the action of the other with the result we are rapidly approaching a condition which, if not changed quickly, will result seriously to the nation. We should realize that industrial victories, like military victories, are won by courage, patriotism, unity and confidence.

I would remind you that we were five years reaching the present basis of prices and we cannot return to former prices and conditions in a few months. I doubt if we want to go back even if it were possible.

I would also remind you that during the last year there was very little, if any, money made by the producers and manufacturers of road building materials.

Brick Prices for Example

Unfortunately I did not have the privilege of hearing the speech of Governor Cox from Ohio, but read it last night, and while no man in Ohio stands higher in my estimation than Governor Cox, I am afraid that he is working under a misapprehension or from wrong information in regard to road material prices. He referred to the increase in prices of various materials, one of which was brick. I was informed by one of the large producers of brick in Ohio, over the phone last evening, that in November, 1917, his contract prices were $20 per thousand delivered, to which was to be added any increase for labor, fuel and freight. In June, 1918, for deliveries upon the same contracts his price was $25 per thousand and he assumed whatever increase there might have been in labor, fuel and freight rates. In 1919 his price is $25 and while it is true that his fuel has been reduced slightly his increase in the cost of labor since 1917 is considerably more than 100 percent and labor is more than 70 percent of the cost of producing brick.

Another feature surrounding the manufacture of brick is that the manufacturers have met the request of the government to keep labor employed with the result that hundreds of thousands of brick are piled in their various yards and are not being used because of the present attitude toward public improvements. It is needless to say that the employment of this labor cannot continue very long unless there is a different attitude on the part of those responsible for public work.

Cement Prices

I am also afraid Governor Cox's information in regard to the increase on cement was unreliable inasmuch as I am informed from reliable sources that the price of cement at the mills supplying Ohio is 15c per barrel higher than it was one year ago and no higher than ten months ago. During this period of ten months there was one raise in freight rates upon incoming commodities and two wage increases.

I do not believe the road material industries are less patriotic than any other class of people and, notwithstanding the fact that many of their industries were practically closed during the war, they were loyal to every call upon them and today stand ready to meet every obligation to their government.

Commodity Prices, Cotton for Example

Recently I read the following statement from the Cotton Publicity Committee: "The southern farmer has learned that his labor is worth more than four pounds of salt meat, a peck of meal and two or three yams every week—and perhaps a few clothes and a pair of shoes once a year. The southern boy and girl will not live on the farm any longer unless it offers more comforts. The southern people are done with shacks and cabins for homes and streaks of mud for roads. They want houses, well paved roads, good schools, and better opportunities for their children. The southern farmer is going to get a fair price for his labor. Cotton will never go back to starvation prices." Notwithstanding that statement I am reliably informed that the cotton growers are now demanding and waiting for a reduction in the cost of fertilizer and so it goes.

Farm Products Buy More Roads Now Than Formerly

A different attitude was shown by a prominent farmer in reference to road building. He said: "The farmer today can buy more roads with his products than he could a few years ago under former price conditions, and while the cost of road building has gone up, the price which the farmer receives for his products has registered a much higher advance, so that 100 lbs. of milk, or a bushel of grain, will buy more roads today than it would in 1914."

On Monday it was recommended by Lieut. Governor Oglesby, of Illinois, that the government pocket the loss on wheat and pork and allow the farmer to go back to normal conditions. What did he mean by "normal conditions" Does he intend to go back to conditions prior to the war when thousands of men were leaving the farms because of unattractive and unsatisfactory labor conditions or does he mean to allow the farm labor a living wage, and if he allows that, will he be able to reduce the cost of living for the labor entering into the manufacture and production of materials entering into road construction?

Labor Cost

When you consider that at least seventy-five percent of the cost of road construction, from the raw materials to the finished road, is labor, I do not see where we can expect much reduction in road building so long as the wages and the cost of living remain where they are. You can have roads at lower cost, but not without disturbing labor conditions.

Views of an Eminent Economist

I desire to quote from a recent statement from a well known authority, Mr. Irving Fisher, professor of Political Economy of Yale University. Mr. Fisher says:

"At the present time there is a marked halt in production. Industry is slowing down. Unemployment of labor increases. Some industrial concerns are failing to earn profits, and others are suffering the dissipation of their accrued profits because, even by shutting their plants down, they cannot save certain of their expenses or any of their fixed charges. The government's revenues, dependent as they are upon the national income, may fall short at the very time we need them most. In brief, we are threatened with a widespread business depression and from peculiar causes, for the unsound conditions usually preceding a widespread business depression are absent."

No Case Exceptional

"The main reason why business is not going ahead better is that most people expect prices to drop. The merchant is selling, but not buying. The manufacturer holds up the purchase of his raw materials. People quote the disparity between present prices and those prevailing "before the war," and decide they will not buy much until present prices get to "normal." This general conviction that prices are sure to drop is putting a brake upon the entire machinery of production and distribution. Readjustment waits because we keep on waiting for it. We have waited in vain for over three months. It is interesting to observe that many manufacturers think that prices must come down, including the price of labor, but they are ready to demonstrate to you that their own prices cannot come down, nor can they pay lower wages. Almost everything they buy somehow costs twice as much as before the war, and their labor is twice as dear. They cannot pay their labor less, if labor is to meet the increased cost of living. Now, as a matter of fact, when we investigate almost any individual one of the so-called "high prices" for industrial products, we are likely to find that individually it is not high, that is, it is not high relative to the rest. Our quarrel is with the general level of prices."

Prices on New and Permanently Higher Level

"The fundamental practical question confronting business men is whether the general level of prices is going to fall. In my opinion, it is not going to fall much, if at all. We are on a permanently higher price level and the sooner the business men of the country take this view and adjust themselves to it, the sooner they will save themselves and the nation from the misfortune which will come, if we persist in our present false hope."

"The general level of prices is dependent upon the volume and rapidity of turnover of the circulating medium in relation to the business to be transacted thereby. If the number of dollars circulated by cash and check doubles, while the amount of goods and service exchanged thereby remain constant, prices will about double.

"The great price changes in history have come about in just this manner. The 'price revolution' of the sixteenth century came upon Europe as a result of the great influx of gold and silver from the mines of the New World. Europe was flooded with new money. More centers were used than before in effecting exchanges, and prices became 'high.' People talked then of *temporary* 'inflation,' just as they talk of it now. But it was not temporary; it was a new price level.

Not Clever to Wait

"Business men should face the facts. To talk reverently of 1913-14 prices is to speak a dead language today. The buyers of the country, since the armistice, have made an unexampled attack upon prices through their waiting attitude, and yet price recessions have been insignificant. The reason is that we are on a new high price level, which will be found a stubborn reality. Business men are going to find out that the clever man is not the man who waits, but the one who finds out the new price facts, and acts accordingly."

The surest way to secure a readjustment of conditions, including prices, will be to start industry going and bring it to a normal business basis as quickly as possible. It is not fair to consider today's prices with those of the days when business men were failing because of the general unrest throughout the country which resulted in cut-throat competition, low wages and *of course* low cost of materials.

The value of a citizen to a community is not increased by forcing bankruptcy upon that citizen. Low price of materials under such conditions become high priced, and that is just what will occur in this country if the federal, state and county governmental agencies do not establish confidence in the country by a go-ahead policy in public work. If you men representing the various states and municipalities do not go ahead with your work you cannot expect private capital to do so, and if neither proceeds the result will be serious not only to the road building industries, but the same spirit of "hold-back" will extend to all lines of industry.

The Cost of Delay

The cost of delay in proceeding with your road building programs is in my estimation more serious than the increased cost of construction. The joint committee on Federal Aid in the construction of post roads, sixty-third congress, reported after a careful investigation that the United States was paying annually a penalty in excessive cost of rural hauling of $504,000,000. These figures have increased considerably because commerce to be transported over our roads, combined with the opening of new roads, far exceeds the improvement of roads. They are also based upon horse drawn haulage, consequently, the saving from motor vehicle haulage would greatly increase the penalty. Every state in the union is sharing in that penalty.

One of the main arguments for the recent $200,000,000 increase in the federal aid was that it would encourage the states to go ahead immediately with their road building programs by assisting them in meeting the higher cost of construction, and to accomplish that, the original federal aid law was amended by increasing from $10,000 to $20,000, the cost per mile for federal aid participation.

It has been said that some manufacturers have stated that the price of materials could be reduced but that reduction was being prevented by certain leaders of the industries. If such is the case, and there are sound reasons whereby reductions in price of road building materials may be made, they should be, and without delay, but I would remind you of a statement made during the war by Mr. Edward N. Hurley, based upon government investigation, that many of the manufacturers did not know their cost of production and that 90 percent had not been making any money and 5 percent less than $5,000 per year.

We are sometimes too willing to cry graft and extortion. More than any other nation on earth we stand in need of good roads and thousands of miles of them.

The adjustment of prices to what may be the new normal level can be accompanied by prosperity just as great as we have had during the raising of prices providing we keep right on doing business.

With capital and labor which has been devoted to the war turned into avenues of production for the things which are so essential to our industrial progress and economic life, the earnings of that capital and labor will develop an enormous market for shoes, clothing, food and all the other commodities made for the comfort, or to meet the desires of mankind.

With consuming and purchasing power thus sustained our farms and factories will continue to teem with activity and prosperity will abound throughout the entire land.

With capital and labor fully and profitably employed the only price effect will be the adjustment and probably decline of speculative prices—a result that can but little affect the normal level of legitimate values.

Conclusion

Now, I have endeavored to give you definite, tangible facts which show clearly the fundamentals of the situation. The understanding of this situation if confined solely to this audience can do little to aid in the solution of the immediate and pressing problem.

If the public as a whole can be brought to a quick realization of the facts we can all go ahead confidently and enter the era of great prosperity which is certainly ultimately ahead of America.

I believe that you should be preaching these facts to your communities and should not wait for the logic of events to force the public to the correct understanding.

Machine Finishing Concrete Roads

By E. G. Carr, Consulting Highway Engineer, The Lakewood Engineering Co., Cleveland, Ohio.

A concrete road may be defined as a slab of concrete upon a country roadway to provide a hard surface for traffic under all weather conditions.

It will be assumed in this article that the slab has been properly designed with reference to the character of the soil and the traffic to be carried. These problems must be solved by the knowledge and experience of the engineer. It is the object of this article to direct attention more particularly to the character of the concrete slab and its construction.

Concrete in roads is subjected to more severe conditions than are ordinarily encountered when it is used for other purposes—abrasion of the surface and the pounding effect of traffic which causes strains not common in other concrete structures.

Concrete in Roads Must be Best Obtainable

A continuous slab of concrete on country soil is also subject to expansion and contraction caused by changes in temperature and water absorption. Hence, concrete for roads must be better concrete. It must be more dense and uniform than for most other uses. A small amount of inferior concrete in a wall may be protected and supported by the stronger concrete surrounding it. In a road the traffic hunts out the weak spots with fiendish ingenuity, and these places will fail regardless of how good the surrounding concrete may be.

Concrete cannot be compressed like a bale of cotton, and it can be compacted only by creating a flowing or crawling action in the concrete mass, so that the larger aggregate will settle closer together, and the smaller particles will fill the remaining voids.

Three Methods of Reducing Voids in Concrete

There are three ways in common in molding concrete to

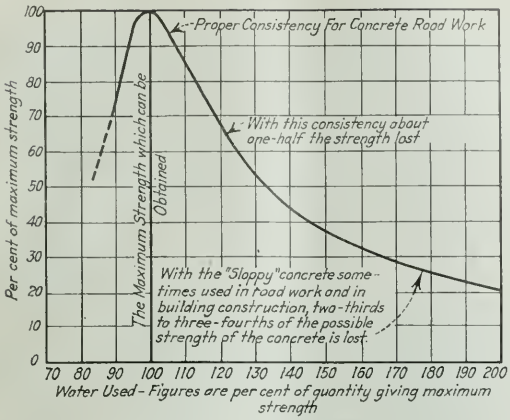

Per cent of maximum strength
100
90
80
70
60
50
40
30
20
10
0
70 80 90 100 110 120 130 140 150 160 170 180 190 200
Water Used - Figures are per cent of quantity giving maximum strength
Proper Consistency For Concrete Road Work
With this consistency about one-half the strength lost
The Maximum Strength which can be Obtained
With the "Sloppy" concrete sometimes used in road work and in building construction, two-thirds to three-fourths of the possible strength of the concrete is lost

DIAGRAM SHOWING EFFECT OF WATER ON THE STRENGTH OF CONCRETE.

reduce voids. Two are detrimental and one beneficial to the strength of the product and all three generally employed in varying degrees.

One way is to add excess water until the concrete literally flows in place by gravity. Another method is to use finer aggregate so that there will be less voids to fill. The third way is to stir it, tamp it, roll it, shake it or anything to move the more loosely arranged aggregate so that they will fall into closer and more compact position.

Effect of Excess Water

The use of excess water impairs the strength, makes the concrete porous and causes the lighter material to float to the top and cover the surface with laitance and foreign material, which may have found its way into the mixture. In some concrete structures there is an advantage in having the best concrete at the bottom, but it is evident that the best concrete should be at the top of a road.

Engineers have long known that an excess amount of water used in mixing will cause a considerable loss of strength in the concrete. Exactly what ratio exists between water content and strength has recently been shown by the extensive investigations of Professor D. A. Abrams of Lewis Institute, Chicago. The accompanying curve gives the results of his experiments.

The use of too much water cannot be blamed unreservedly on the contractor because heretofore methods had not been developed for the practical use of stiff concrete for roads.

Use of Fine Aggregate

The size of the aggregate governs largely the amount of water needed to give a workable concrete. The smaller aggregate requires more water.

If a road were built of a rich mixture of cement and fine aggregate, the cost would be excessive and the expansion and contraction would be greater than if a mixture of fine and coarse aggregate had been used. Moreover, when a contraction crack forms in a concrete road, the coarse aggregate dovetails the slabs together, holding them in their original relative positions.

The greater the proportion of good, clean stone, mixed in a given consistency of cement mortar without forming voids, the better the concrete will be for roads.

Mechanical Compacting of Concrete

While concrete used for building roads presents more than the ordinary disadvantages to the use of excess water or fine aggregate, it offers exceptional opportunities for mechanical compacting on account of its accessibility.

The method of applying force in mechanical compacting must be such that the larger pieces will not be displaced after they have settled to their best relative positions. The applied force must not drive a stone past the best place for that stone to stop, and the only available means for stopping that stone at the right place is the increased resistance offered to the movement of the stone by a more compact mass than the mass in, and with which the stone is moving.

Assume that we have an agitating force with a limited violence or a tamper with a given stroke. A greater frequency of strokes enables us to make a stiffer concrete flow.

It is this principle—the rapidity of agitation—which yields the unique advantage that mechanical tamping has over hand work.

Under a rapid succession of strokes, the concrete literally flows as a result of the agitation and the mass is in a semi-liquid condition. The drier and coarser the concrete, the less it will move under the influence of a single stroke, and the sooner it will be at rest again. To obtain the advantages of a moving friction, the succeeding stroke must come while the concrete is still in motion.

Voids in concrete are a source of weakness and, if beneath the surface, may not be detected until the ravelling of the aggregate under traffic exposes them. Therefore, the effect of the agitation must be in all directions and the agitation must be

VIEWS ILLUSTRATING THE MACHINE FINISHING OF CONCRETE ROADS.

Top: Machine Superior to Hand Methods in Producing Uniform Pavement Body and Surface—Center: Machine Spreads, Tamps and Finishes Concrete, Striking Ten Times in its Own Width—Bottom: Concrete of this Consistency makes the Strongest Road but is very Difficult to Strike and Finish by Hand. The Machine Handles it Easily.

continued and repeated until there is a reasonable certainty that the desired result has been accomplished.

Starting with these ideas, the writer developed the concrete road finishing machine shown here.

Concrete Road Finishing Machine

After numerous experiments it was found to be exceptionally advantageous to utilize suction for the purpose of agitating the concrete mass.

If the concrete in walls, for example, be agitated, it will be noticed that the concrete near the surface is easily shaken into shape, while it is difficult to produce any movement in the bottom of a deep layer of concrete, on account of the weight of the concrete above. This is so obvious that it would seem to be unnecessary to direct attention to it. Any additional pressure in the direction of the force of gravity tends to bridge, arch or bind the aggregate in the positions assumed under the force of gravity instead of facilitating any movement in the mass that would rearrange the aggregate into more compact positions. A keystone of an arch is not displayed by downward pressure upon it.

It was found that by creating a vacuum above the concrete mass in one place, mortar was forced towards the vacuum space, disrupting the binding of the aggregate, and permitting

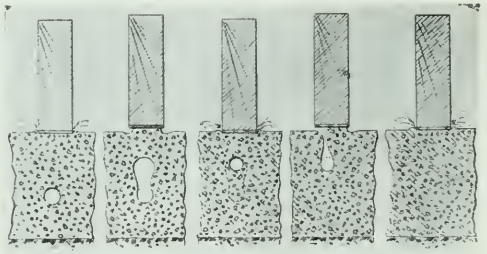


DIAGRAM ILLUSTRATING HOW ENTRAPPED AIR IS REMOVED FROM GREEN CONCRETE BY ALTERNATING PRESSURE.

Left to Right: 1, Air Compressed. 2, Air Expanded in Path of Least Resistance. 3, Air Bubble Again Compressed Nearer Surface. 4, Air Bubble Breaking Through Surface. 5, Air Bubble Entirely Removed.

the pieces to settle into more compact positions—hitting the keystone from the bottom, so to speak. The idea can be well illustrated by a log jam. Force applied to the up-stream side of the jam only wedges the mass more firmly; it would be readily broken by pressure applied below the jam by a reversal of the current.

In the machine illustrated, the suction is obtained by the tamper templet, which is raised with a jerk after hitting the concrete—alternately driving the concrete away and jerking it back. This action removes the entrapped air, giving a dense concrete.

The machine illustrated is so constructed that the speed, length and intensity of the strokes can be varied at the will of the operator to meet all the different consistencies of concrete and conditions found in road work.

A laborer tamping concrete, would pass over the surface if it appeared finished. The machine tamps thoroughly and uniformly. As it works forward and backward, it attacks a bad arrangement of aggregate, first from one direction and then from the other, insuring a slab of uniform density.

Besides the advantage of more thoroughly and uniformly compacted concrete, machine finishing is a more dependable means of obtaining a true, even surface—thereby reducing the vibration and wear on the pavement and vehicles.

Acknowledgement

The foregoing paper was presented as a part of the Short Course in Highway Engineering, given at the University of Illinois, Urbana, Feb. 18, 1919.

Sterilization of Water and Sewage

An attractively printed bulletin is being distributed to illustrate a few of the many contributions of the technical staff of the Wallace & Tiernan Co., Inc. (349 Broadway, New York) to winning the war. Among the most interesting achievements of this staff was the conception, design and construction of large fleets of water pumping, purification and laboratory trucks. These units were always ready for action and accompanied our troops to supply absolutely pure water from grossly polluted streams. Liquid chlorine and W. & T. apparatus were used to sterilize all the water pumped as it is recognized that no water is safe until it is sterilized. In domestic water supply sterilization, it should be noted, water-borne diseases can be absolutely eliminated at a cost of less than 50 cents per 1,000,000 gals. The W. & T. booklet "Why" gives the reason for sterilizing water and sewage.

The Dry Feeding of Chemicals Used in Water Purification

By F. B. Leopold, Vice President, Pittsburgh Filter Manufacturing Co., Farmers' Bank Bldg., Pittsburgh, Pa.

In the design and operation of filtration plants one of the most important features is the method of applying the coagulant to the water to be treated.

Former Practice

Since the inception of mechanical filtration, the making of solutions and the application of the solutions to the water has been the generally accepted plan of treatment. The use of solutions has always been attended with more or less difficulty, due primarily to the fact that in order to avoid the extreme cost of large solution tanks that would be necessary to make up dilute solutions, the practice has been to use solutions of considerable strength and in consequence of a highly corrosive nature, with a consequent rapid deterioration of all materials which it came in contact with. Pumps were used largely in the earlier days, to pump the solutions from tanks that were located below the floor line of the building, in order to avoid taking up valuable and costly space in building construction.

Present Practice

However, the cost of maintenance of pumping apparatus and piping connections proving so excessive, the latter-day practice has been the elevation of solution tanks into upper parts of the building and then feeding by gravity through constant head orifice tanks, using as short line connections as possible to reduce to the minimum the depreciation cost.

This, however, has meant a very considerable increase in the cost of building construction, due to the necessary supports of tanks and the considerable space occupied by the solution tanks. It has been recognized for many years that a satisfactory method of measuring and feeding pulverized materials that would avoid the use of solution tanks, and simplify and reduce the quantity of piping necessary, was the ultimate ideal solution of this vexatious question.

A number of different devices have from time to time been used with more or less success, but there has, so far, evidently been lacking some essential detail necessary to their successful operation and extensive use.

Dry-Feed Process at St. Louis, Mo.

The city of St. Louis has been using a dry-feed process for a considerable number of years. The apparatus, however, is an extremely elaborate and expensive proposition, beyond the reach of most large plants and utterly out of consideration for the average plant.

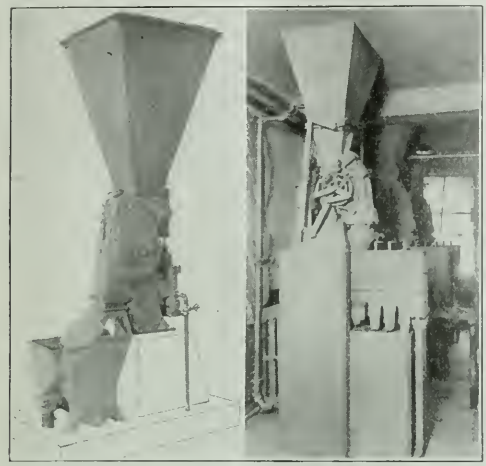
A New Machine Developed for Dry Feeding

The Pittsburgh Filter Manufacturing Company has been experimenting with a number of different devices and designs and have finally developed a machine that will meet the popular need and be low enough in cost to come into general use. This machine, after being constructed, was given a consider-

able test in the shop, and one of the machines was then placed in operation in the city of Toledo filtration plant, where it has been operating continuously day and night for over two and one-half years. It has required practically no attention and has given no serious difficulty, while the results in the treatment of the water, or the application of the chemicals, has shown a more uniform treatment than by the old solution method originally used. Since then these machines have been installed for the use of pulverized alum, iron, soda ash and lime, with most gratifying results.

Dry Feeding in the Great Falls, Mont., Plant

In the construction of the 12,000,000-gal. plant at Great Falls, Mont., solution tanks were entirely omitted, from the design, and the chemical feed provided for entirely by the installation of three of these dry-feed machines, set in a battery.



DRY FEED APPARATUS FOR WATER PURIFICATION PLANTS.

Left: Latest Design Machine Showing All Parts Enclosed; Glass Observation Doors; Dust Proof. Right: Battery of Dry Feed Machines in Service at Great Falls, Mont., Water Purification Plant.

These three machines with their hoppers occupy about one-half of the space that would have been required for one solution tank, while in order to provide for continuous feeding of solution two solution tanks would have been required for each chemical used. The saving, therefore, in the construction cost at this plant has paid for the dry-feed installation several times over in the initial cost.

Dry Feeding at Flint, Mich.

The city of Flint, Mich., increased the capacity of their filtration plant from 8 to 16,000,000 gals. per day, abandoned the solution tanks and installed this system of dry feeding of chemicals. By the system to be installed there the pulverized chemicals will be unloaded into bins located over the dry-feed machines, and after the one handling of the material from the car to the bin the entire operation is by gravity into the daily hopper of the machine and from there to the solution mixing chambers. In addition to the economy in installation there is the added economy in the operation due to the single handling of the material that cannot be avoided where solutions are necessary to be made in the ordinary way.

Description of the Machine

The machine is simple in form, readily accessible in all parts, comparatively little to wear, and that easily replaceable. It is subject to a wide variation in range of feeding. The machine illustrated has a range of from 150 lbs. per 24 hours up to 15,000 lbs. per 24 hours. It is an accurate feed through all stages of this range.

It consists of a main cast iron housing, into which is fitted a roughened drum wheel, upon which the material rests and which carries the material forward through an adjustable orifice. The degree of opening and therefore the rate of feed is indicated by a pointer on one side of the frame of the machine. This feed wheel is operated by a ratchet wheel attached to the same shaft and on the outside of the framework. The ratchet in turn is operated by a motor.

Adjusting the Feed

There are three means of adjusting the feed to the required amount. First, by the orifice opening; second, by the adjustment of the ratchet to the number of teeth that the pawl engages at each stroke; third, by the speed of the motor. This gives an extremely wide range of adjustment. One side of the machine is open, or rather is covered by a cover plate, which, when removed, allows the removal of all the internal working parts of the machine, without the necessity of taking it apart or from its location. Each machine is operated by an absolute displacement piston motor mounted on the same frame with the machine. This motor may be arranged to operate at any given number of strokes per minute that is desired, and by the use of proper controlling device in conjunction with the Venturi tube can be arranged to operate proportionately to the flow of water that it is desired to treat. With each machine is furnished a cast iron mixing box or chamber, into which the dry material is discharged. This is a cast iron box with removable baffles, to enable the convenient cleaning of any sediment that may accumulate in the bottom.

Regulating Strength of Solution

Water for dissolving is introduced into a mixing chamber immediately below the point at which the dry material is discharged into the mixing chamber, and can be introduced in any quantity or portion desired. In other words, the solution may be made as weak as desirable to avoid the corrosive action of the solution on the piping system used to carry the solution to the final entrance to the water to be treated.

By this arrangement materials can be used for this work that, with the ordinary strength of solution necessary when solution tanks are employed, would be impossible by reason of the corrosive action.

This system of feeding dry chemicals is now in use at Great Falls, Mont., Grand Forks, N. D., Fort Madison, Ia., Tulsa, Okla., Spartanburg, S. C., and Toledo, O., filtration plants, and has been contracted for in many other cities in plants varying from 1,000,000 to 10,000,000 gals. capacity. With the test of time proving out the expectations of the manufacturer, they should work a revolution in this feature of the design of filtration plants and will undoubtedly result in many of the present plants being changed from solution to dry feed.

The present type of machine is designed for plants varying from 4,000,000 to 5,000,000 gals. up to approximately 25,000,000 or 30,000,000 gals., or even larger.

Design Features of Sewage Disposal Plant at Industrial Housing Development of the Alan Wood Iron and Steel Co., at Swedeland, Pa.

By George L. Robinson, Consulting Engineer, 37-39 E. 28th Street, New York, N. Y.

From the plans of Messrs. Savery and Scheetz, Architects, of Philadelphia, the Alan Wood Iron and Steel Co., have built up a most attractive industrial housing development which at present has some hundred substantial brick houses for the superintendents, foremen and workmen at Swedeland, Pennsylvania.

The location of the village on the Schuylkill river made it necessary to provide an adequate sewage disposal plant to treat the domestic sewage produced by the community.

Sewage Collection

The village is located on a hillside well above the river and the sewer lines are planned of such sizes and grades that

they may take not only the domestic sewage from the population about to occupy the development, but may be added to from time to time as the village growth may warrant. It is supposed that the maximum future growth of the village will not produce more than 250,000 gals. per day; that is, perhaps 500 houses with 5 persons to the house.

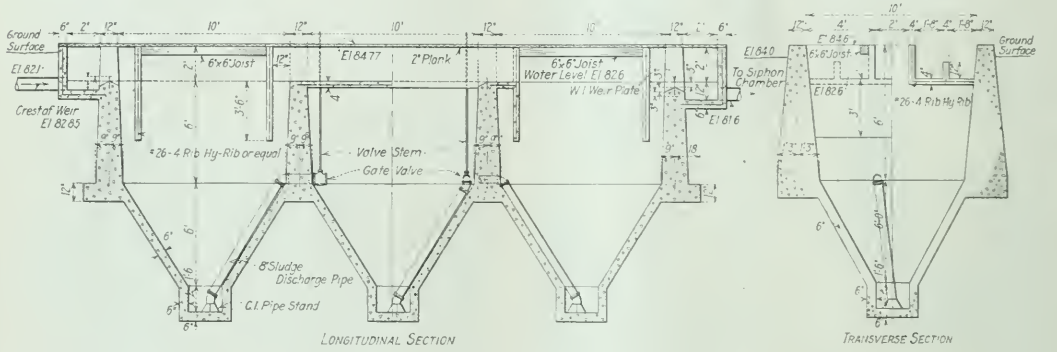
Sewage Disposal

The disposal plant is designed to receive the domestic sewage from 100 houses with an estimated population of 5 persons in each house. An allowance of 100 gals. per person per 24 hours, or 50,000 gals. per 24 hours, is taken as the basis of the design.

Elements of the Disposal Plant

(1) A screen chamber to remove such very heavy matter as might pass through the sewer, and which it would be undesirable to have enter the settling tank. Provision is made for future enlargement and extension if the growth of the village warrants it.

(2) A settling tank which is planned along the lines recommended by the United States Housing Corporation, of which John W. Alvord is chief engineer.



SECTIONS OF SETTLING TANKS OF SEWAGE DISPOSAL PLANT OF THE ALAN WOOD & STEEL CO., AT SWEDELAND, PA.

The structure is made up of three bays or hopper tanks, the details of which are shown herewith. The sewage enters the first compartment, and, after passing under the baffle walls, passes out through troughs over the second (or sludge) tank into the third (or second settling) compartment, thence to the siphon dosing chamber beyond.

The arrangement of this group of hoppers permits double settling and the withdrawal of sludge from time to time to the sludge digestion bay or hopper. This plan obviates the gas chambers and self-contained sludge digestion chambers used in the Imhoff tanks.

The sludge pipe arrangement, valves, troughs, baffles, etc., are all plainly shown and the scheme of operation is self-evident.

The Alan Wood Iron and Steel Company will bring to the site of the disposal plant a water line and provide a fire hydrant so that water jet through hose and nozzle may be used in flushing sludge or floating mat from settling tank into digestion hopper, or in starting flow to sludge bed, or for the purpose of introducing fresh water with its oxygen content into either the settling tank or the digestion hopper.

(3) The siphon chamber provides for a dose of about 1,000 gals. This will take up the maximum flow and permit the spraying on the bed beyond at a rate of about once every 18 minutes maximum and about once every hour minimum. There will be an 8-in. Miller siphon with a maximum head on the filter of 6 ft.

(4) The sprinkling filter receives the water from the siphon chamber. This bed offers an area of 1,755 sq. ft., or a little more than .04 of an acre. This is a sprinkling rate of 1,250,000 gals. per acre per day, with a filtering depth of stone of 5½ ft.

The sprinklers will be Taylor "hexagonal," fed from cast iron 4-in. distribution pipes and 3-in. cast iron risers.

The stone or slag (2-in. to 3-in.) filter material will be underdrained by 12-in. vitrified half-pipe. The filter material will be supported by a 6-in. concrete floor, sloping for drainage; concrete walls at the sides.

(5) The sterilizing outfit consists of a brick house to contain a Wallace & Tiernan Company's chlorinating apparatus, and a concrete chamber, in which the chlorine will be liberated from a submerged diffuser.

From this unit the sterilized effluent will pass through a 10-in. vitrified sewer to a culvert under the tracks and thence to the river.

(6) The sludge beds provide a surface area of 1,540 sq. ft., or 770 sq. ft. each side of the partition plank. It is not intended to draw more than 400 cu. ft. of sludge at one time. The underdrains from the sludge bed pass to the sterilizing outfit, so that the filtered sludge water will be treated before it reaches the river.

It is proposed to add additional units to the plant as the population increases, so that the rate of settlement and filtration may be maintained within proper limits.

Equipment and Methods Employed in Building Sewers in San Francisco, Calif.

By H. W. Shimer, Assistant City Engineer, San Francisco, Calif.

San Francisco, being situated on the tidewater, has a comparatively simple sewage disposal problem. In the early days of the city the sewers were discharged into the bay at the most convenient points. As the city grew, the sewage increased in quantity and became a nuisance in certain places along the water front. In some sections of the city the old sewers were inadequate. This led to the adoption of a general plan of constructing interceptors, reconstructing sewers that were inadequate, and the construction of storm water relief sewers. This work has been under way for about 15 years and has not as yet been completed.

The disposal scheme adopted is to discharge the sewage only at points where there are strong tidal currents. Overflow structures and relief sewers discharging into the bay at convenient points are provided to take care of the storm water.

A great deal of this work has been done on busy streets, all of it involved handling the flow of existing sewers, and some of it was tide work.

Another feature of the sewer construction is the building of sewers to serve new districts. These, however, are usually in the open country or sparsely settled districts and are located

on hillsides, where there are no flat grades and where there are no existing sewers to deal with.

This work has been divided into small sections and let by contract. The largest contract only involved $223,000, while the work thus far completed has cost well over $6,000,000. With so many contractors there has been a great variety of methods and equipment. The writer will only attempt to describe the methods and equipment that experience has shown to be the best.

Pipe Sewers

A description of the equipment and methods used in the construction of sewers in San Francisco can best be done by dealing with pipe sewers and concrete sewers separately. The pipe sewers are easy to construct. The excavation is comparatively light, and the methods are accordingly simple.

The equipment seldom consists of more than some lumber for lagging and some picks and shovels, and even the picks are not required in sand. Concrete sewers require much more elaborate methods, and sometimes considerable equipment. The construction of brick sewers has been discontinued in this city.

The pipe sewers are made of vitrified, salt-glazed ironstone pipe, varying in size from 8-in. to 24-in. The 8-in. to 12-in. is single strength and the 15-in. to 24-in. is double strength. The joints are made with 1:1 cement mortar. A gasket of hemp dipped in cement grout is inserted in the joint of the double-strength pipe before the mortar is put in. This holds the pipe in line and prevents the mortar from being pushed through into the pipe.

Trenching

The pipe sewers are about 10 ft. deep and the excavation is usually done by hand. Conditions are favorable for the use of trenching machines only in a few instances. A great many of the jobs are in loose sand, and others are in streets where there are many obstructions.

However, trenching machines have been used in a few cases.

Sewers of this class are constructed in districts where there is no objection to storing the excavated material in the street.

Method of Timbering

The method of timbering used consists of digging holes with a post auger and setting 4x4-in. posts long enough to reach a few inches below the bottom of the trench. These posts are placed in pairs, one on either side of the trench, and 8 ft. apart along the trench. As the excavation is carried down, 2-in. planks are inserted behind the posts and the dirt carefully packed behind them and braces are placed between the posts as needed.

Pipe Laying

Pipe laying follows as close behind the excavation as possible. The pipe-laying crew usually consists of four men, two in the trench and two on top. Of the two men in the trench, one prepares the trench for the pipe and the other makes the joints. The two work together in laying the pipe. The pipe is lowered into the trench with a rope by the two men on the surface, who also mix the mortar and handle the plumbbob and grade stick.

Backfilling

The backfilling is usually done by hand. The first foot is hand tamped. The remainder is hand tamped or flooded with water, depending upon the character of the soil. The lagging is removed as backfilling proceeds. In a few special cases where the ground was very wet or treacherous, or the trench was of unusual depth, some of the methods of excavation or timbering used on concrete sewers have been adopted.

VIEWS ON SEWER CONSTRUCTION IN SAN FRANCISCO.

Driving Sheeting with Steam Hammer Excavating Bucket in Foreground—Derrick Equipped with an Orange Peel Bucket, Lagging Started and being Driven by Hand—Removing 3x5 ft. Brick Sewer and Old Cable Railroad Slots to Make Way for an 8 ft. Sewer.

Concrete Sewers

The standard sizes and shapes of concrete sewers built in San Francisco are 2x3 ft. and 2 ft. 6 ins. x 3 ft. 9 ins., which are egg shape, but with a slab top, instead of an arch; 3 ft. x 4 ft. 6 ins. and up to 4 ft. x 6 ft., which are of the standard egg shape, and circular sewers with diameters from 3 ft. to 9 ft. Various odd shapes and sizes have been built to meet unusual conditions.

The depth of excavation varies from practically nothing where the sewer follows a creek bottom to cuts of 25 or 30 ft. The materials encountered are rock, clay, sandy clay, loose sand and very wet sand.

Excavation

The excavation of the shallower trenches is done by hand. The deeper trenches are usually excavated by a derrick equipped with orange peel, clam shell or dump buckets. These derricks are of the stiff-leg variety, and are usually mounted on a platform spanning the trench. The platform is mounted on rollers, which enables it to be easily moved as the excava-

tion progresses. The derrick is equipped with a two-drum donkey engine and an auxiliary swinging engine. Fuel oil is usually used under the boiler. The crew consists of an engineer and a signal man and sometimes a fireman.

Rock excavation is neither hard enough nor extensive enough to warrant the installation of air drills. When blasting is necessary, drilling is done by hand. The explosive is 40 percent dynamite and black powder.

Trenching machines have been used on a few jobs, but conditions are usually such that their use is impracticable. Steam shovels have been used to a very limited extent to take out the main body of excavation.

The excavated material is stored along the side of the trench except on busy streets, or where it would interfere with traffic. Here the city requires the material to be removed as fast as excavated.

Timbering

The only timbering used in rock, clay and sandy clay is an occasional timber brace to guard against slips. In loose or wet materials, vertical timber sheeting is used with timber walings and braces. The sheeting is 2x8-in. or 3x9-in. plank and, if the ground is very wet sand, they are tongued and grooved. They are driven with wooden mauls or small steam hammers. The steam hammer is suspended from a wooden frame with a chain block. The frame is so constructed that the hammer can be moved easily from one plank to another. When it is necessary to move the frame, it is done by the derrick. The steam is furnished by the boiler on the derrick. The sheeting is driven about 3 ft. at a time and proceeds with the excavation. After the backfilling is completed, the sheeting is usually pulled by hand with a lever about 12 or 14 ft. long. A clamp is used that tightens by pulling sidewise. If a derrick is used for backfilling, the sheeting is pulled by it.

Supporting Sewers on Piles

Old marshes and swamps that have been filled in are continually subsiding. To keep a sewer to line and grade it is necessary to support it on piles. These piles are sometimes driven before the trench is excavated, but usually afterwards.

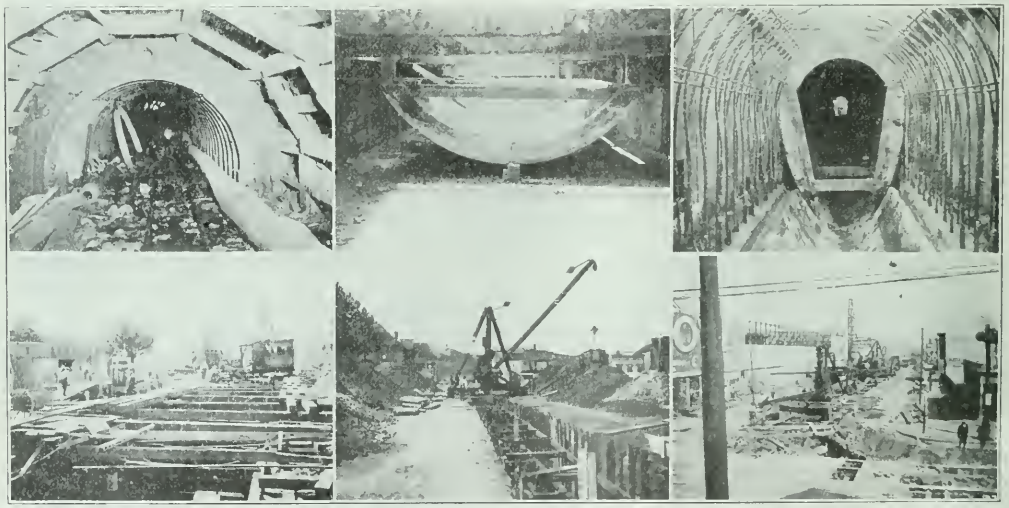
The pile drivers are mounted on skids, and are supported on greased sills spanning the trench. They are equipped with a two-drum oil-burning donkey engine. An effort is made to use a driver tall enough to handle easily the longest pile required up to 60 or 70 ft. If piles longer than 60 ft. are required, splicing is permitted. The type of splice found to be most satisfactory consists of a dowel about 4 ft. long and a piece of steel casing about 2½ or 3 ft. long, and just large enough to fit the smaller pile end.

Most of the pile drivers are equipped with No. 1 Vulcan steam hammers. The other hammers used are the No. 2 Vulcan and a 3,000-lb. drop hammer. The material through which piles are driven is mud and sand, and the No. 1 Vulcan gives the best results.

The piles are driven to within a foot of subgrade when possible.

Underdrains

If running water is encountered in the trench, an underdrain is used, consisting of vitrified bell and spigot pipe surrounded with crushed rock. The bottom of the trench is covered with crushed rock to give a clean, dry surface on which to pour concrete. The joints of the pipe are caulked with oakum, leaving a small opening on the top to admit a small quantity of water. It is desirable to take as much of the water into the open end of the pipe as possible. If the pipe could be laid with tight joints, no water would be taken from under completed work.



MISCELLANEOUS VIEWS ON SEWER CONSTRUCTION IN SAN FRANCISCO.

Top Row: Mile Rock Tunnel, Showing Timbering, Completed Concrete, Forms, Ventilating Pipe and Delivery Pipe from Pneumatic Concrete Mixer—Sewer Invert Form in Place—4x6 ft. Sewer Showing Invert with Vitrified Brick Lining, Steel and Forms. Bottom Row: Some of the Equipment used on a 9x11 ft. Sewer—Derrick with Bucket in Soft Rock —Equipment used on an 8 ft. Circular Sewer Built on Piles.

Considerable skill is required to keep an underdrain open, and running for any considerable distance in sand bearing large quantities of water. Sometimes a rope is carried along inside the pipe to assist in freeing the pipe of sand. A hose with water under pressure is sometimes resorted to. Tees projecting up through the invert are put in from 100 to 300 ft. apart. These are very useful in keeping the drain open and also in plugging it after the sewer is completed. The plugging is done by flushing in as much sand as possible, and then putting concrete plugs in all the tees.

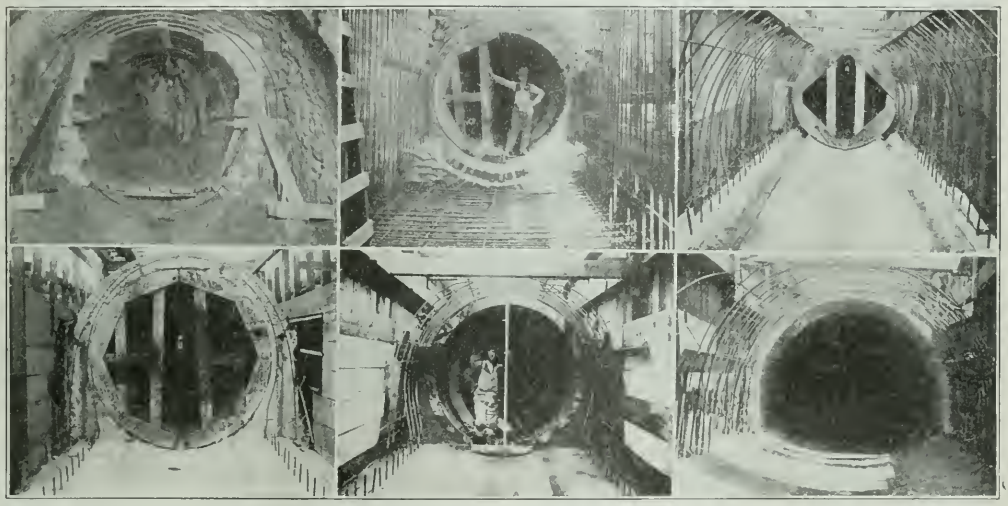
The underdrains are led in sumps usually just outside the trench but occasionally in the bottom of the trench. Great precautions are necessary to have the sumps tight so that no sand can get into them from under the sewer.

Centrifugal pumps electrically driven are generally used.

If the quantity of water is not great, and the condition of the trench is such that no particular damage will be done if the pump goes out of commission, an automatic control is often used.

Invert Construction

As soon as the underdrain is laid the reinforcing steel is placed if any is required and the invert forms are set. Forms for the invert give much more satisfactory results than a template and straight edge, and also save considerable plastering or chipping. The forms are of wood and 8 ft. long. They are supported and braced from the trench braces, and walings. The forms are removed the next morning after the concrete is poured and a lining of vitrified brick constructed. As soon as the mortar has thoroughly set, the reinforcing steel is placed, and the top and side forms are set. These forms are also made of wood, and are usually 8 ft. long. They are built in two or three pieces. The two piece forms are somewhat easier to set, but the three piece forms can be removed and carried through other forms that have been recently set.



VIEWS ON SEWER CONSTRUCTION IN SAN FRANCISCO, CALIF.

Top Row: Hunter Point 6 ft. Circular Sewer, Shoveling Concrete into Forms.—Circular Sewer, 8 ft. 6 in. Diameter—8 ft. 6 in. Circular Sewer Showing Invert with Brick Lining and Forms and Steel in Place for Sides and Top. Bottom Row: 8 ft. 6 in. Circular Sewer with Forms in Place—8 ft. Circular Sewer Showing 3-Piece Forms in Place with Others Inside—9x11 ft. Horseshoe Sewer.

Concreting

The concrete proportions are 1:2¼:5 and the materials are Portland cement, sand and crushed rock or gravel. The sand and rock are piled along side of the trench as conveniently as possible. Where the material can be piled continuously along close to the trench, the mixer is located on the edge of the trench and the concrete is conveyed directly from the mixer into the forms through chutes and the machine is moved as often as necessary. Where the rock and sand can not be stored close to the trench or only at intervals several hundred feet apart the mixer is installed close to the materials, and the concrete is transported in buggies to the chutes. One interesting installation was a mixer installed on a platform that spanned the trench. The materials were wheeled up runways that were a part of the platform. The concrete was deposited through short chutes. The platform was moved by the donkey engine of a nearby derrick.

The power used is generally a gasoline engine but sometimes steam is used or electricity if power wires are handy.

Backfilling Concrete Sewer Trenches

The backfilling is done by hand, with Mormon scrapers, or with clamshell buckets operated by a derrick depending upon the kind of material and whether or not the backfill must be compacted. If this trench is to be paved over, the backfill is compacted by hand tamping or flooding with water.

Tunnels

Within the last ten years, six tunnels have been dug in connection with sewer building. All but one of the tunnels have been in rock of varying degrees of hardness. The varying degrees of hardness sometimes occur very close together on the same job. For this reason it is often impossible to prevent large overbreak. The excavation proceeded in the manner customary in small tunnels. In the smaller tunnels the drilling was done by hand and the muck was hauled out by hand. In the larger tunnels compressed air drills were used and the muck was hauled out with mules. Various methods of concreting have been used. The usual method has been to have the mixer located near the portal or a shaft. The concrete was conveyed by chutes to cars in the tunnel. These cars were dumped either directly into the forms or into boxes, and the concrete shoveled into the forms. The sheathing of the forms was built up as the concreting progressed.

Pneumatic Concreting

In the last tunnel job a pneumatic mixer was used. With this process the forms are completely set up before the concreting starts. The end of the concrete discharge pipe is placed in the forms, the concreting then proceeds until the forms are filled without any interruption to the tunnel excavation. The force of the concrete insures that all the holes and cracks will be filled. The crew consists of a foreman, three men at the mixer and one or two tampers. The concrete is of excellent quality and the method has proven highly satisfactory.

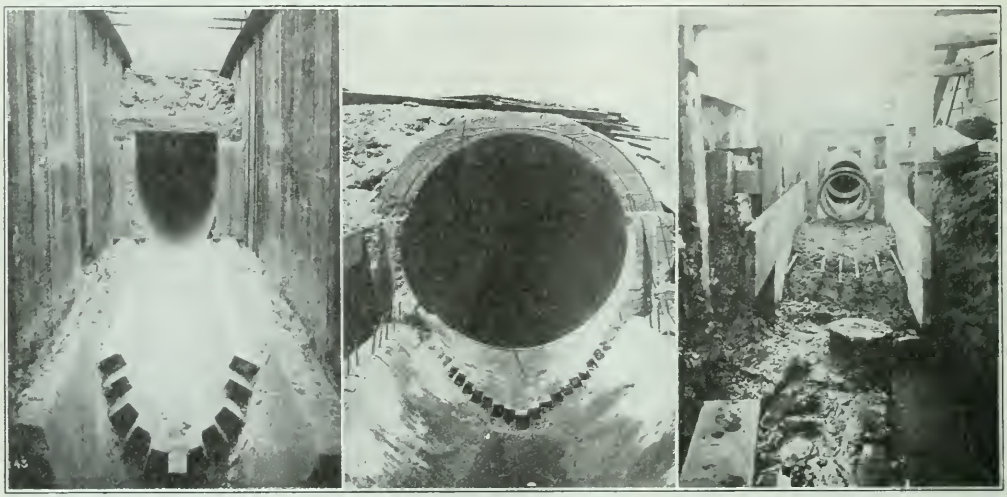
Particular attention has been paid to getting all overbreak and spaces around timbers entirely filled. This has been done in a number of ways. One inch sheathing has been nailed to the inside of the timber sets and all spaces filled with sand. Considerable quantities of rock have been used with concrete in the overbreak.

The most satisfactory method was to fill the large overbreak with rough masonry composed of rock taken from the tunnel and lean cement mortar, depending on the concrete to fill the smaller spaces.

All the sewage of San Francisco is discharged into San Francisco Bay. Most of the outfalls discharging at the elevation of low water require slightly different methods from the ordinary sewer construction. The outfall structure usually is built through the loose rock sea wall. A single row of sheeting suffices for the sides of a light cofferdam, but on account of the loose rock it is not possible to unwater the last foot or so of the trench even at low tide. The usual method is to concrete the invert at low tide depositing the concrete in the shallowest portion of the trench and continuing to pour concrete into concrete instead of into water. After the concreting is finished the water is allowed to rise with the tide. Care is taken that there is no wash of water on or through the concrete. When carefully done the concrete has been found to be of first class quality.

Two submerged outfalls required strong well built cofferdams that could be entirely unwatered.

All sewer work in San Francisco is done under the direction of M. M. O'Shaughnessy, city engineer.



VIEWS ON SEWER CONSTRUCTION IN SAN FRANCISCO.

2x3 ft. Concrete Sewer with Brick Lined Invert—5 ft. Circular Concrete Sewer with Brick Lined Invert—24 in. Vitrified Pipe Sewer Supported on Piles and Surrounded with Reinforced Concrete.

Military Roads as Constructed and Projected by the Construction Division, War Department, U. S. A., in 1918

By Daniel B. Goodsell, Highway Engineer, Construction Division, War Department, Washington, D. C.

The road work at the National Army, National Guard and other camps, terminals, storehouses, etc., has been prosecuted under most adverse conditions during the last 1½ years due to the necessity of immediate completion and the use of the most available material.

Materials of Construction

The National Army camps or cantonments are better provided with roads than the National Guard or tent camps. For both of these classes of camps gravel, chert, slag or shell was the material immediately available and largely used. For the quartermaster's warehouse and main heavy traffic roads concrete was used extensively. This material found its place at fire stations where apparatus is washed, opposite garages and incinerators, manure loading platforms and coal trestles and other places where a hard, impervious surface was a necessity and it has fully justified its use by good service.

Bituminous macadam or penetration method roads were quickly constructed, almost immediately available for use and have proved satisfactory in many of the camps even under hard usage.

The problem of maintenance under war conditions with all the different kinds of pavements has been a difficult matter, due to lack of material, labor and expert highway engineers.

The construction of concrete pavements during the winter of 1917-1918 was attended with some failures due to freezing and the desire to use such roads before they were fit. In the main, the results have been good, although considerable work was done during the severe winter.

During the early stages of construction of camps, the paving work was prosecuted by the general contractor in charge of the building of the entire camp. This method was altered later, the roads being contracted for separately on a cost plus basis on account of the need for expert supervision, the large amount of work involved, and to secure expedition.

Cost Plus Contracts Commended

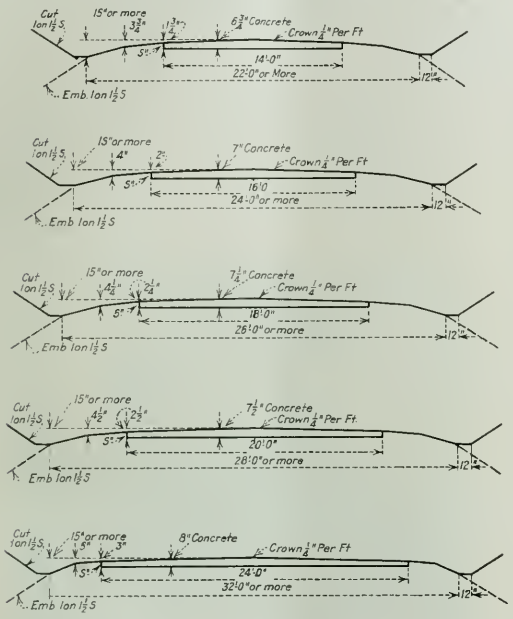
The cost plus type of contract has proved its worth in road work as in other construction. It enabled the contractor to do his work quickly and with a limited amount of friction. Brigadier General Marshall, Chief of Construction Division of the War Department, in commenting on the system before the Association of General Contractors of America, stated: "The great lesson of this war on the subject of the relationship between the contractor and the owner is the cost-plus contract. This represents the only equitable basis upon which a contractor may perform constructive and economic services for the owner. It is the only form of contract which affords protection to both parties. All of the energies, the thought and the experience of this country within its own continental lines during the past year and one-half of this world struggle shall have been in vain unless out of it shall grow, as a permanent institution, solidifying the economic relationship between the contractor and the owner, the cost-plus contract." Also before the American Society of Civil Engineers—"They have saved—and this is demonstrable—to the Government a vast amount of money. They have operated with smoothness, flexibility and with surprisingly little misunderstanding or friction between the Government and the many contractors in question. Without them the vast building program of the

Army which has been successfully accomplished would have been a matter of utter impossibility."

"The sole justification for the cost-plus contract as used during the war is not the uncertain and unstable condition brought about by the war, for the cost-plus contract, properly administered, is the proper conservative and just method of doing contracting work—just alike to the owner, the engineer and the contractor."

Costs

With more leisure at hand, projected road work at the cantonments, camps, posts, etc., will probably cost less. About 866 miles of road were constructed at a cost of about $21,000,000 by the Construction Division of the War Department during the war period. Concrete roads cost from $30,000 to $65,000 per mile for widths of 13 ft. including grading and drainage, or an average of about $3.25 per sq. yd., with a more complete maintenance provided for and closer supervision a much lower ultimate cost is obtainable.



TYPICAL CROSS SECTIONS OF CEMENT CONCRETE PAVEMENTS BUILT BY CONSTRUCTION DIVISION, U. S. WAR DEPARTMENT IN 1918.

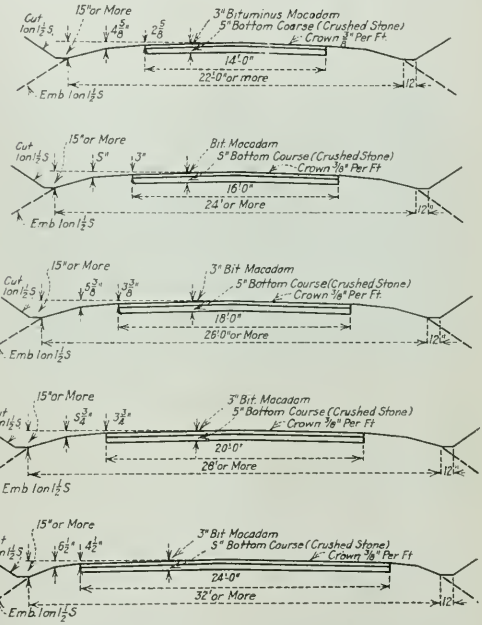
That the War Department should undertake the construction of those highways which connect in any one vicinity its military posts, warehouses, terminals or other utilities without regard as to whether such highways are on Government owned property or not is a question presented for consideration.

Many claims have been made for roads destroyed by army trucks during the war period. Much of this damage has been due to lack of maintenance. Prompt repairs, not possible at times, would have saved municipal and county authorities much money and would have formed the basis of a reasonable claim for reimbursement by the Government, in addition to aiding the war. Such cases were rare.

Abstracts From "Instruction to Constructing Quartermasters"

Principles of Design—Width

The width of roads should be governed by the number of lines of traffic and the speed at which it may be necessary to move them, more clearance being given for high speed, which is defined as above 15 miles per hour. The 5-ton truck used by the Army has over all dimensions of 7 ft. 6in.x21 ft. Trucks of these maximum dimensions require at least 2 ft. 6 ins. for clearance at a speed of 12 miles, which fixes the roadway for this kind of traffic at 20 ft.; where mule teams and light autos constitute a large percentage of the traffic and where the width of vehicles is not above 6 ft. 3 ins., a roadway of 18 ft. is sufficient. Less than this width should not be used unless traffic be light, slow moving, and the roadway constructed with substantial shoulders of bituminous or gravel macadam, the consideration being that any light traffic roadway may suddenly become heavy traffic, due to its use as a detour, or a change in camp conditions.



TYPICAL CROSS SECTIONS OF BITUMINOUS MACADAM PAVEMENTS (PENETRATION METHOD) AS BUILT BY CONSTRUCTION DIVISION, U. S. WAR DEPARTMENT, IN 1918.

Considerable difference of opinion has apparently existed among construction quartermasters as to the location and width needed for warehouse roads. A 5-ton truck requires, when backed up square to a warehouse platform, 33 ft. in which to turn. A maximum width of 42 ft. therefore is sufficient for backing and turning, the main road to be 24 ft. with wings of 18 ft. opposite the platforms. Manure loading platforms require a width sufficient for one line of traffic only as do the coal trestles and ordance storehouses.

Roads to trestles, incinerators and can-washing plants should be arranged in loops to afford continuous movement of traffic with ample loading space.

At all curves of less radius than 400 ft., the width of the pavement should be increased from 2 to 4 ft. and surface banked.

Thickness

Thickness of concrete pavement should be governed by (1) width, (2) the heaviest unit of traffic which will pass over it, and (3) subsoil conditions, such as whether the sub-grade is well compacted, subject to shrinkage, as is the case of trenches recently backfilled, or subject to washouts or the ground water not drained to low enough level. Limits of thickness

MILEAGE OF ROADS IN CAMPS, ETC., AS BUILT BY CONSTRUCTION DIVISION, WAR DEPARTMENT, AS OF JANUARY 1, 1919.

Types	National Army Camps	National Guard Camps	Miscell. Camps	Terminals	Regular Army Posts	Coast Art. & Miscell. Camps	Total
Cement concrete	65.10	16.45	52.11	45.00	.....	....	158.66
Gravel	150.36	101.54	6.33	....	....	....	258.25
Bit. macadam	70.44	31.95	11.11	.....	112.00	....	225.50
W. B. macadam	38.43	15.24	49.37	20.00	200.00	32.30	355.34
Cinder and shell	1.74	3.68	7.08	....	.....	....	12.50
Sand clay	4.83	20.71	.....	....	.....	....	25.54
Slag macadam	0.28	.....	2.08	....	.....	....	2.36
Bit. concrete	....	.....	.....	....	.....	....	.....
Brick	0.95	.....	5.26	....	.....	....	6.21
Unpaved	53.62	83.51	18.51	....	.....	....	155.64
Total	385.75	273.08	131.87	65.00	312.00	32.30	1,200.00

for different widths of roads are shown on accompanying cross-section of roadway.

Type

Consideration should be given first of all to availability of material in selecting the kind of pavement with a view to avoiding as far as possible transportation of materials or machinery by rail for long distances. Secondly, the material must be selected to suit the traffic—concrete, brick, bituminous concrete, bituminous macadam and waterbound macadam or gravel or broken stone in the order named for the density of traffic estimated. For roads at the divisional warehouses, where much turning of vehicles occurs, concrete, brick or other hard surfaced pavement is to be preferred.

At incinerators and fire stations, etc., where vehicles are washed, or at manure loading platforms concrete or brick is to be preferred for sanitary reasons.

Grades

Topography is the limiting condition for grades, due to the fact that it should be the practice to avoid cuts of 3 ft. or more in the grading work. A deeper cut or fill may be justified, however, on the ground of avoiding a short steep grade of 4 percent or more, or a long grade of 5 percent or more in an artillery or balloon camp.

Alignment

Alignment at curves and intersections, where the view is obscured should be given attention, the road to be widened and banks or other obstructions cleared. The locating of roads close to barracks or kitchens so that there is insufficient room for road gutters and surface drainage, should be avoided and roads should be curved to fit the topography and avoid heavy cuts or fills, where such a location is possible.

Radius of curvature at corners should not be less than 15 ft.

Radius of main traffic roads should not be less than 200 ft. for speed of 15 miles per hour.

Drainage

The practice of constructing wearing surface prior to the contemplation of the drainage is not approved except under cases of extreme urgency. It is advised that a survey and plan be made showing the culverts, ditches, tile pipes, gratings, pipe drains or other drainage accessories and that this work of drainage be prosecuted far in advance of that of the wearing surface.

The construction of shoulders should proceed simultaneously with that of the wearing surface and they should be of road gravel, cinders or broken stones, if the wearing surface be of concrete or other hard material.

The work has been prosecuted under the direction of Major Leonard S. Doten, Q. M. C. up to July and since then under Major H. J. Philips, Q. M. C., as Advisory Engineer of roads to the Construction Division of the War Department.

New Model P. & H. Excavator With Side Wheel

A new model excavator with side wheel, here illustrated, has been added to the Pawling & Harnischfeger line. This machine was introduced to fill the want for an excavator able to dig close to curbing, pole lines, walls and to operate in other closely restricted quarters where a trench is to be dug.

This ditcher with standard side clearance cutters is designed to dig a trench 15 ins. wide to a maximum depth of 4 ft. Side clearance cutters can be furnished to enable the machine to dig to a maximum width of 24 ins. The machine is built of high-grade material throughout and the construction is first-class in every respect. All gears are made either of steel castings or forgings, and all high-speed gears have teeth cut from the solid. All chain sprockets are steel castings. All parts running on shafts are bronze bushed. The chains connecting the engine to the machinery and those driving the digging wheel are of steel of the roller type. Bearings carrying shafts of intermeshing gears are cast together wherever practicable in order to insure permanent alignment.

Corduroy grip tractions are provided for supporting the rear or heavy end of the machine. The machine is driven by a 25-h.p., 4-cylinder vertical engine of the tractor type, arranged for burning either kerosene, gasoline, or motor spirits. A tank is provided for gasoline and another larger tank for kerosene or motor spirits. The engine is water cooled. The

VIEW OF THE NEW SIDE WHEEL PAWLING & HARNISCHFEGER EXCAVATOR IN OPERATION.

operating levers are placed at the back of the car body and are so grouped that they can all be reached from one position.

The digging wheel is of the open type without axle, arranged to obtain the maximum depth of trench with minimum diameter of wheel. The hoisting drum for raising and lowering the wheel frame is mounted on the car body and connected with the jack shaft by means of a steel roller chain. The steering machinery is mounted under the car body, and is operated by a worm and worm wheel which are self-locking. The steel belt conveyor for removing the spool is 24 ins. wide and of sufficient length to dispose of material when digging at the maximum depth.

The general dimensions of this ditcher are: Width, 10 ft. 7 ins.; length of car body, 18 ft.; length over all, 25 ft. 9 ins.; height over all, 9 ft. 7½ ins.; weight on corduroy grip tractions, 19,500 lbs.

The Sioux Falls Spillway for Flood Relief of the Big Sioux River, South Dakota

By Francis C. Shenchon, Mem. Am. Soc. C. E., Consulting Hydraulic Engineer, 628 Metropolitan Bank Bldg., Minneapolis, Minn.

The Big Sioux River has its course in the northeastern corner of South Dakota. This region is characterized by a number of small lakes which doubtless have some reservoir value in absorbing flood waters. The river flows southward and has a length, as the crow flies, of about 150 miles, before it reaches Sioux Falls where the spillway to be described is located. The river itself meanders and doubles upon itself in a devious course which doubtless makes the line of travel of the water as much as 300 miles. The drainage basin above Sioux Falls is over 4,000 square miles in area. Approaching this city the river traverses bottom lands in which its bed is but slightly depressed below the general level of the country. The sub-soil is fine sand readily scoured and the river channel has shifted from time to time over this flood plain.

From time immemorial the river under stress of flood conditions has overflowed its banks and spread over the bottom lands. While this has created temporary inundations of some inconvenience, the great fertility of the soil is doubtless to be credited to the overflow. The sedimentary deposit from the sanding flood waters is a fertilizer.

Main Ditches

To assist the early drying-out in the spring of these rich bottom lands for cultivation and seeding, and to escape the hazard of overflow during the crop-growing season, two main ditches were excavated about ten years ago. Ditch No. 1 taps the river about three miles north of Sioux Falls and ditch No. 2 taps the river twelve miles above Sioux Falls, and joins ditch No. 1 about two miles above the city. While varying somewhat in section, the ditches may be thought of as 30 ft. wide at bottom, 54 ft. wide at water surface and 8 ft. deep in flood times. The river which approaches Sioux Falls from the north passes on west of the city, then makes a loop, which measured along the sinuous course of the river is about 26 miles long; then the river returns northward to Sioux Falls, descends over a red quartzite bottom, and passes on north again from the city at an elevation about 115 ft. below the elevation of its first approach.

The ditches mentioned above emerge from the river on the higher level passing toward the bank overlooking the river on its lower level. This bank is of clay and hills rising about 20 ft. to 40 ft. from a rim along the south edge of the upper valley.

The Original Spillway

To drain the ditches into the lower river gorge a cut was made through this clay rim and down the sloping bank towards the river; and this excavated cut was lined with light reinforced concrete. This was the original spillway and served for a number of years. In flowing down this concrete trough however the water had a descent of about 110 ft. in a distance of about 1,000 ft. This of course gave a high velocity and great destructive power to the water where it debouched into the river. I understand there was also a tendency for the water to escape under the lining. Ultimately

FIG. 2. CONTROLLING AND INTAKE SLUICES OF SIOUX FALLS SPILLWAY UNDER CONSTRUCTION.

in the spring of 1916 a flood of considerable magnitude wrecked the spillway and a gorge was cut back towards the clay rim of hills mentioned above, for a distance of 900 ft. This gorge has a depth of 100 ft., and has a width of about 300 ft. (See Figs. 1 and 5.)

New Spillway Designed to Absorb Energy of Water

Minnehaha County was faced with the need of putting in a spillway which would safely carry a flood flow somewhat

FIG. 1. VIEW SHOWING THE WRECKING OF THE OLD SIOUX FALLS SPILLWAY IN 1916.

in excess of that of the old spillway. It appeared a perplexing problem to the Board of County Commissioners, and in August 1917, the writer was called upon to design a structure which which would accomplish the desired purpose of safely taking 2,000 cu. ft. of water per second (900,000 gals. a minute) from the level of the valley floor to the level of the river in the gorge.

The problem presented was to absorb the energy of the water without destructive effects. Ordinarily a hydraulic engineer must build a structure to conserve the energy of water and convert it into useful power. Here the engineer was called upon to destroy the energy of water endowed with 25,000 potential water horse power.

Stated another way the problem was to affect the descent through 110 ft. of 5,400,000 tons of water a day, with a velocity

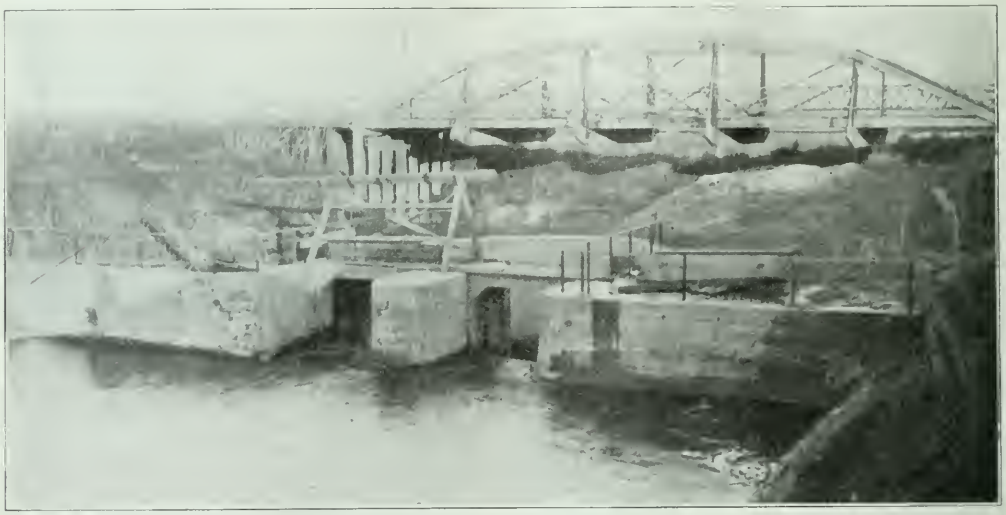


FIG. 3. VIEW SHOWING INTAKE SLUICES OF SIOUX FALLS SPILLWAY IN OPERATION DURING FLOOD OF MARCH, 1919.

in passing through the spillway of 35 miles an hour; and this water must be denied the possibility of the destruction which its enormous energy makes so menacing. It should be noted that active flow through the spillway does not take place more than a few weeks each year and therefore its development for water power is not financially feasible.

Sluiceways and Tunnel.

In working out a solution of this problem it was decided to enlarge the ditch for a short distance to slow up its velocity as it approached the descent; to pave with the local jasper or red quartzite a distance of 70 ft; then pass the water through sluiceways 8 ft. wide and 18 ft. deep. These sluiceways are provided with stop-logs so that control of the flow may be effected in case of need or desirability. The dimensions of the sluiceways give a flow of 2,000 cu. ft. per second when the water is 12 ft. deep over the sluiceway floor. With the water 2 ft. higher the discharge through the sluices will be 2,500 cu. ft. per second. (See Figs. 2 and 3.) After passing through the sluices the water drops into a shaft which tapers from 16 ft. in diameter at the water suface above, to 10 ft. in diameter at the bottom. In this shaft the water drops vertically 40 ft. and is then deflected by a great elbow into the tunnel which leads towards the gorge below. The tunnel has a level floor crosswise, 10 ft. wide, with vertical side walls 3 ft. high. The upper portion of the tunnel is a semi-circle of 10 ft. diameter. The tunnel takes the water from the foot of the shaft through the clay hills, and has a length of 216 ft., descending on a grade of [illegible] (See Fig. 4.)

The Stilling Basin

At the tunnel portal, where it emerges in the gorge, the water passes through an open flume with vertical walls 8 ft. high and a floor 10 ft. wide. With a flow of 2,000 cu. ft. per second it is calculated that the stream will be 4 ft. deep and have a velocity of about 35 miles per hour. This stream then impinges on an overhead curving deflector beam which changes the direction of the water through an angle of 80 degrees, spreads it out laterally fan-shape as it descends, and projects it vertically into a stilling basin, 24 ft. wide and 25 ft. deep. This stilling basin is of massive reinforced concrete construction, and is founded on a mass of red quartzite embedded in coarse gravel. The foundation was solidly locked to the rock and the gravel spaces grouted under pressure. A reinforced concrete floor was placed over portions of the bottom where gravel seams were exposed. The larger part of the bottom of the basin is red quartzite, a rock so hard that it will cut glass.

The water projected into this stilling basin in a sheet perhaps 2 ft. thick and 24 ft. wide has its condition of a stream of high velocity and small section, converted to a stream of large section and small velocity. By frictional losses, expansion, and the lifting and changing of direction of the mass of water its destructive energy is largely eliminated as it emerges from the basin and flows towards the river.

The principal absorption of energy takes place in the basin, but the water issuing from the basin over a sill 15 ft. below the flood water surface and 20 ft. wide, does have left some considerable velocity and turbulence. The secondary expansion takes place outside the basin, but turbulence disappears 60 ft. down stream from the basin, where the water is running straight-away in a stream 100 ft. wide, towards the river.

Method of Making Hydraulic Excavation

In the original drafts for design it was proposed to extend the structure down stream about 80 ft. from the deep basin so as to contain within reinforced concrete walls the secondary turbulence. The foundation difficulties were found so great however in putting in the deep basin in sand under 20 ft. of water, that it was finally decided to let the water

excavate its own outer basin in the gorge. This was successfully accomplished in the 8-day flood beginning March 15 of this year.

In order to accomplish this hydraulic excavation without danger of landslides, stop-logs were placed in the sluiceways to cut the discharge down to 1,200 cu. ft. per second. Fig. 5 illustrates the hydraulic conditions of the emerging flood water in the gorge with this volume of flow. Where the heavy boiler shows, about 25 ft. down-stream from the stilling basin, the water is 30 ft. deep with rock bottom. Characteristic lateral eddies have scoured the gorge walls out as shown. When the flood flow began the basin was hemmed in tightly by steep slopes on each side. After eight days of discharge the basin has plenty of elbow room and is in no danger from lateral landslides.

Geological Conditions

The geological conditions exposed in the gorge walls show a top stratum of yellow clay of little tenacity tending to break down when saturated; under this is a stratum about 100 ft. thick of blue clay as tenacious as rubber and resisting current wash; underneath this blue clay is a bed of fine quartz sand saturated by small spring flow; below the sand are massive fragments of red quartzite embedded in coarse gravel, overlying the bed rock.

Getting down to adequate foundations for the stilling basin

FIG. 4. VIEW SHOWING SMALL FLOW IN THE TUNNEL OF THE SIOUX FALLS SPILLWAY.

in this saturated sand was difficult. Water leaking into the cofferdam of steel sheet piling brought considerable sand with it and caused one serious landslide, and some minor slides.

Details

The shaft and tunnel were driven through the blue clay, which stood up without shoring, except in one section of the tunnel where a pocket of sand, gravel and water was encountered, which emptied about 200 cu. yds. of material into the tunnel. For the most part the tunnel was blasted and cut out of the tenacious blue clay, forming an opening 14 ft. wide and 12 ft. high.

The paving in the approach canal (See Fig. 2) is 1 ft. thick of quartzite blocks with cement mortar in joints. At the entrance to the sluiceways a concrete cut-off wall is sunk 6 ft. into the blue clay.

The controlling works, wing walls, sluice walls and shaft walls are of reinforced concrete 2 ft. thick. At the foot of the shaft, where the tunnel begins, the walls are heavier to meet the great stress of an 80 degree turn of the water. The tunnel and flume walls and floors are 2 ft. thick of reinforced concrete. The walls of the stilling basin are 3 ft. thick, heavily reinforced.

Protecting Concrete Against Erosion

In the old spillway the concrete was badly scoured by the swift silt-bearing water. In the new spillway all surfaces

FIG. 5. VIEW SHOWING OUTFLOW THROUGH GORGE, SIOUX FALLS SPILLWAY, DURING FLOOD OF MARCH, 1919.

subject to the wear of high velocity flow are lined with red quartzite block built integral with the concrete. In Fig. 4 these walls of stone are 4 ft. high, with additional height near the elbow at the foot of the shaft. This is the estimated depth of the normal flood flow stream.

The flume is bridged from the tunnel portal to the stilling basin, so that the earth may drop away below it without hurt. This flume serves also to anchor the basin against overturning. It will safely transmit from the basin to the earthbound tunnel more than 200 tons.

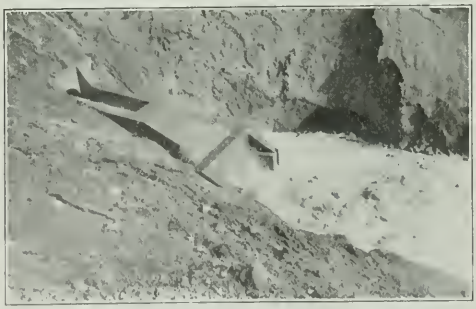


FIG. 6. VIEW SHOWING TUNNEL PORTAL, BRIDGED FLUME, DEFLECTOR AND STILLING BASIN, WITH 1,200 CU. FT. PER SECOND DISCHARGE, SIOUX FALLS SPILLWAY.

Returning now to the stilling basin outlet, and the secondary turbulence in the gorge outside the basin, the question arises why a condition hazardous to the structure does not exist in the possibility of the swift current washing out the underlying sand and toppling the clay banks down. That is exactly what did occur when the flood wash began, but the

restriction of the volume of flow widened the gorge near the basin gradually. Little landslides were caused which dropped into the swift current and were washed away. But these landslides did not work upstream. That was closely watched and guarded against. After a sufficient gorge width has been hydraulically excavated, the sand will be covered over by a talis bank of blue clay which confines and protects it. The toppling down of the blue clay automatically provides this protective cover.

When the flood has passed and a condition of channel equilibrium is reached, the banks close to the basin will further be protected by a cover of large rock fragments to take the wash. The rock fill will be especially heavy where needed to check any possibility of upstream encroachment.

Personnel

The plans were approved by the State Engineer of South Dakota, Dr. Homer M. Derr, who made valuable suggestions for their betterment. Dr. Derr would have preferred a spillway of greater capacity than 2,000 cu. sec. ft.

The work was done by the Sioux Falls Construction Company, and appears to be an excellent job. Mr. L. M. Norelius was resident engineer.

The Board of County Commissioners has worked cordially with the engineers and the contractor to produce an enduring and interesting hydraulic structure.

The Importance of Adequate Drainage and Foundations for Road and Street Surfaces

By Clifford Richardson, Consulting Engineer, The Barber Asphalt Paving Co., Woolworth Bldg., New York, N. Y.

The satisfactory nature of any type of pavement or road surface is primarily dependent on the rigidity of the foundation which supports it. Inadequacy in this respect reduces all forms of construction to a common level of inferiority. Rigidity in a road surface cannot be obtained without suitable under-drainage and, for this reason, drainage is a feature of primary importance in the construction of roads and pavements.

Historical

This fact has been recognized for at least a century, but it has seldom been carried out effectively. The ideas of the older engineers, McAdam, Telford and others, in regard to road construction and the importance of the relation of drainage thereto, are widely scattered through the earlier literature of the subject. They were recognized and summarized in an interesting book by S. DeWitt Bloodgood, published at Albany, N. Y. in 1838, entitled, "A Treatise on Roads", in which it is found that sound principles had been established in the United States at that early date, by engineers who had an adequate comprehension of the subject, at least as far as the requirements of their day were concerned.

That this was a fact can be realized from some of Mr. Bloodgood's statements:

> "The strength of a road depends on the nature of the material of which it is formed, and of the basis on which it is placed."
>
> "McAdam's theory of road-making may be comprised in the following quotation from his Report to the Board of Agriculture, (vol. vi.p.46):—'Roads can never be rendered perfectly secure until the following principles be fully understood, admitted and acted upon, namely, that it is the native soil which really supports the weight of traffic; that while it is preserved in a dry state it will carry any weight without sinking, and that it does, in fact, carry the road and the carriages also; that this native soil must previously be made quite dry, and a covering impenetrable to rain must then be placed over it, to preserve it in a dry state.'"
>
> "The erroneous opinion so long acted upon, and so tenaciously adhered to that by placing a large quantity of stone under the roads, a remedy will be found for the sinking into wet clay or other soft soils; or, in other words, that a road may be sufficiently strong, artificially, to carry heavy carriages, though the sub-soil be in a wet state, and by such means to avert the inconveniences of the natural soil receiving water from rain or other causes has produced most of the defects of the roads of Great Britain. At one time, McAdam had formed the opinion that this practice was only a useless expense; but experience has convinced him that it is likewise positively injurious."
>
> "Drainage: In proper construction in this part of the business of road making, great care is necessary. The utmost judgment of the skillful surveyor will be called into action to enable him to make the best use of the natural facilities of the country, and to overcome the obstruction that he will sometimes meet with. In passing over flat land, open main drains, cut on the field side of the fences, must communicate with the natural watercourse of the country; they should be 3 feet deep below the level of the bed of the road, 1 ft. wide at bottom, and 5 ft. wide at top."

With the building of railroads, however, the construction of highways of the better type was gradually neglected, and but little attention was paid to the subject of drainage and foundations, with perhaps some exceptions.

In the seventies of the last century the condition of our roads was such that W. M. Gillespie, in a volume, published in 1872, entitled "A Manual of the Principles and Practice of Road Making," stated in the preface:

> "The common roads of the United States are inferior to those of any other civilized country. Their faults are those of direction, of slopes, of shape, of surface, and generally of deficiency in all the attributes of good roads. Some of these defects are indeed the unavoidable results of the scantiness of capital and of labor in a new country, but most of them arise from an ignorance either of the true principles of road making, or of the advantages of putting these principles into practice."

From this quotation it appears that road construction and maintenance were at a very low ebb at that period. They remained so until the bicycle came into common use. For the comfort of the riders good roads were demanded and a considerable effort was made to provide them. The difficulties of the present period, however, are to be attributed to the fact that motor vehicles and, particularly, motor trucks have become important features in the transportation of passengers and freight over our highways and streets. It is a form of traffic and travel which has made much more serious demands upon them and on the methods of their construction, especially, as regards drainage and foundations. As a result the problems relating thereto demand, and are receiving, more attention today than they have ever had, although their consideration is, even now, too often neglected.*

Drainage at the Present Time

It is evident that the demands made by the traffic which is carried at the present time by our main arteries of communication are such that the greatest stability is necessary for the support of their surfaces, and this can only be accomplished on a soil which is firm or made so by suitable drainage. In arriving at such an end the following points must be given consideration:

The travel and traffic to be carried.
Character of subsoil.
Drainage, natural or artificial.

*"Drainage Increasingly Vital with Growth in Heavy Traffic," by E. W. James—"Public Roads," Vol. 1, No. 3, July, 1918.

Climate.
Location.
Material available for construction.

The relative importance of these features will vary with different local conditions. There is no general rule which applies. In one case the character of the subsoil and the necessary drainage may be the ruling conditions, in another a severe climate, and in a third the material available for construction. Attention must be paid in a certain degree to all of them, however, in any case.

Location

As the solution of the problem of drainage and of the character of the foundation necessary for any particular road is dependent to a very large degree upon its location, the latter is, in this connection, an important consideration. It involves the application of both good judgment and experience, and due regard to the economic principles involved, that is to say, to the relation of the money expended and the results obtained. Like so many other problems which arise in building highways adapted to the use to which they are to be put, it is entirely a local one both financially and structurally.

Soil

As the support of a road surface is the soil upon which it, or its foundation, rests, the stability of the latter, or the imparting of stability to it, is a matter of primary importance.

Soil, as distinguished from sand, which is an aggregation of much coarser particles of mineral matter, is the fine residual of the weathering and decay of rock, associated with more or less organic matter of vegetable origin. Soils are of importance in road building since they form the initial foundation upon which the road is placed. Upon their character is dependent that of the drainage and artificial foundation upon which a road surface or pavement is supported. They may be classified in a general way as sandy, loamy and argillaceous, between which all degrees of gradations exist. Marl and peat are particular forms of soil identified by components which characterize them, in one case shells and in the other a large amount of residual matter of vegetable origin being important components. Any soil may be modified in character by the presence of sand or gravel.

A soil is of interest to the highway engineer chiefly as regards its stability, when properly drained, either naturally or artificially, that is to say, when any excess of water is prevented from accumulation therein in an amount sufficient or more than sufficient to fill the voids between the soil particles, thus involving instability which arises from such a condition. The presence of an amount of moisture only sufficient to be absorbed by the surface of the particles of soil but less than sufficient to fill the voids between the particles, will add to its stability and increase it beyond that of a perfectly dry soil. Sufficient water to form a film on the surface of the soil particles and thus develop a surface energy which will bring about cohesion of these particles may be an advantage as compared to a bone dry condition and undoubtedly exists very generally, but an amount to any degree beyond this would result in instability and also in disturbance by freezing, thawing and refreezing.* This condition is well illustrated by a sandy sea beach where as the tide recedes that portion in which the particles of sand are drained of excess of water, as the tide falls, still contains sufficient for the absorbed film on the surface of the individual grains to develop a surface energy which will bind the particles together in perfectly stable state, and one which will not be displaced under travel, whereas the same sand when perfectly dry, possesses no stability, the same condition existing at the other extreme, at that part of the beach nearer the sea and containing an excess of water. Attention need be called here only to the bearing of this relation on the stability of subsoils and the necessity for drainage. The solution of the problem of under-drainage in road construction is, therefore, largely dependent upon the character of the soil which is to be dealt with, that is to say, the state of subdivision of the particles of which it is composed. It is important that the surface of a road be impervious to water so that the bottom may be dry and stable. If these provisions are lacking every road surface or pavement, of no matter what type, will prove unsatisfactory and give no adequate return for the cost of construction, even with careful maintenance. This is, fortunately, beginning to be recognized.

The drainage demanded by any particular piece of road construction will depend primarily on the character, stability and dryness of the subsoil on which the road rests, its location, relative to its environment, and the climatic conditions which it is called upon to meet. It relates to the removal both of surface and of soil water. The character of the provision for the former will depend upon the surface area and the run-off to be taken care of; for the latter, on the nature of the subsoil upon which the surface is to be placed, the climatic conditions which are to be met, the lay of the surface of the road to that of the adjoining land and the traffic which it is to be called upon to carry.

Drainage is hardly necessary on sandy subsoils, for instance, such as some of those found on Long Island, New York, which in themselves will take care of water, except at low points, but it must be given serious consideration on heavier and especially clay sub-soils, in cuts and fills, particularly the former, and where seepage from slopes or hillsides may destroy the stability of the subsoil and reduce its capacity for carrying a load. In such cases an intercepting gutter for surface water and drain for ground water should be provided between the slope and the road. The necessity for the location of drainage for the removal of ground water should be determined in the spring, when frost is coming out of the ground, and for surface water during storms and periods of high water.

Roads on Fills Should be Drained as Well as in Cuts

The location of a road on a fill does not always insure good drainage if the supporting soil is clay, especially if there is a steep grade on an adjacent portion of the road. An example of a difficulty of this description has been cited by Mr. F. P. Arnold,* of Delaware, who states that:

> "In one location water came from a spring in a cut at the top of a hill, ran down the hill and half way up a fill over a railroad track—a total distance of 1,000 ft. Breaks were found all the way across this fill and when the stone was picked up and a ditch cut through the shoulder at the break furthest from the cut, a 2 in. stream of water ran for nearly a day."

He adds:

> "A stone-filled V-shaped trench, pointing up the hill and placed at the end of every clay cut, will eliminate such breaks in these locations. Furthermore, weeps should be constructed about every 50 ft. to let the water out through the hard shoulder."

This is an excellent example of the fact that a fill should be maintained in as dry a condition as a cut.

The necessity for careful drainage is also emphasized where the soil has no inherent stability in itself, especially when wet, and offers little resistance to displacement.

Drainage may, perhaps, be of less importance, in cases, where a Portland cement concrete foundation is provided, but in general, as evidenced by the behavior of concrete roads, under the action of frost, which develop cracks and defects extending longitudinally, it cannot be disregarded.

Proper drainage of a road is much more essential in

*Engineering & Contracting, 49, 238, 1918.

*Engineering News-Record, 80, 933, Nov. 15, 1917.

climates where frost and low temperatures are encountered than in a moderate or warm one, for reasons which are evident.

In the treatment of subsoils and in the character of the foundation placed upon them, local conditions must be given consideration. The most serious situation exists with clay subsoils which are exposed to extremely low temperatures in winter and which are thrown as the frost comes out of the ground in the spring. Examples which demonstrate this are illustrated by instances where insufficient drainage has been provided for bituminous and waterbound macadam surfaces in northern New York.* The only satisfactory way to meet such a condition is by removing the clay, which is encountered, to the depth that frost reaches, and replacing it with stone or gravel, with proper drainage, which will not be displaced or not as much so, by freezing and thawing.

In considering under ten heads the main problems connected with highway construction, Mr. H. E. Breed,† of the New York Highway Commission, classes the matter of drainage as second only to that of bond issues, calling attention to the fact that, although it is an elementary topic, it is too often neglected like many other self-evident truths. He adds:

"Drainage problems are considered so easy to solve that any one may adequately handle them. True, there is but little theory involved in the application of the principles that make for perfect drainage, but that rare quality known as judgment comes in largely here, as it does in all successful engineering work. Greater care and judgment in respect to drainage are needed now more than ever before in order to increase the bearing power of our soils for the heavier loads that the traffic of today brings upon them.

"This topic may seem more worthy of attention when I tell you that in 1916, 84 miles of improved highways in New York out of a total of 1,939 miles, broke up in the spring of the year. Of this, 43% was directly attributable to inadequate drainage. During 1916 about 75% of these weaker areas was repaired and 238 miles of thin pavement was resurfaced. It may have still more force when I tell you that in New York State in 1917, 48 miles of improved highways out of a total of 2,090 miles broke up in the spring of the year of which 18% was attributable to inadequate drainage.

"The percentages given as attributable to inadequate drainage were reported by the men having charge of each section and the personal equation enters largely into the cause to which each break-up was made attributable. They are, however, the most accurate percentages that could be obtained of the inadequacies of our drainage systems. These roads were not built by guess but under careful calculation by some of the best road engineers in the country. They installed upon them drainage systems such as they thought ample, but they had not taken into account the large increase in traffic and wheel loading that we have today. The roads failed because they disregarded the pumping action caused by the excessive pounding of that traffic, which draws the water and fine material up to and through the crust of the pavement until the crust is broken and the road shattered.

"I shall not attempt to suggest any scheme for the solution of the drainage problem, because each condition requires different treatment. Broadly speaking, however, drainage can be divided into two classes: surface drainage, and sub-surface drainage. Surface drainage is cared for by the crown of the road and side ditches with proper run-off to carry the water away from the road at frequent intervals so that it will not trouble us again as subsurface drainage. Every roadway should have ditches."

No better evidence of the importance of drainage, at least in climates like that of New York State, with severe winters, is needed.

It is unnecessary to go into detail here in regard to systems of drainage for ordinary conditions, since these are described in all their various forms and for different types of pavements and of road construction in text-books, in discussions of the subject before societies, in publications of the United States Office of Public Roads and State Highway Departments and in the engineering press. It is, however, necessary to insist upon the fact that in clay or heavy subsoils, especially in northern climates, if drainage is inadequate no amount of thoroughness in the construction of the foundations and surface of both pavements and roads will result in a satisfactory return for the money expended, even where the traffic is of the most moderate description. Adequate drainage for heavy clay sub-soils, in the coldest climates, can rarely be satisfactorily accomplished, and the only method of meeting such conditions is the excavation of the clay to a considerable depth and its replacement with material which can be drained, or which is not as liable to displacement by frost. In general, it may be said that drainage is a local problem and its satisfactory solution is more dependent on a study of local and individual conditions than upon fixed standards.

Foundations

The first essential in the construction of pavements and road surfaces of durable character having been shown to be a dry, that is to say a well-drained and firm, subsoil, as the result of either natural or artificial provision therefor, upon which to build and maintain a durable surface, another and equally essential factor in the successful construction of both pavements and highways is a suitable foundation. Its character will depend upon the conditions to be met. Practice, which might be excellent in one locality may fail in another. A concrete foundation will, of course, be more costly than one of broken stone, but a foundation of this type 4 ins. in thickness will be stronger than a loose one of 2½ ins. broken stone of 6 ins., and the difference in cost will not be a serious consideration since the much smaller amount of stone used in the 4 in. foundation will largely make up for the cost of the cement and sand in the concrete. In a concrete foundation when once laid, we have an asset which can be counted upon for all time, while a broken stone foundation is necessarily of a more or less temporary nature, owing to its displacement under travel, and disappearance, in some cases, into the soil which should support it.

Concrete Foundations

There seems to be every reason why, in the building of our highways, an effort should be made, at least in the case of those which are to carry heavy travel, to construct them with a concrete foundation, which will last for all time, and on which a wearing surface can be constructed, at such intervals as may be necessary, something which can be easily and economically done, and the life of which depends on the rigidity of the support afforded it. It is evident that as we are now constructing surfaces for many of our main arteries of heavy travel, we are throwing away large quantities of money by lack of inadequate support of them. The result is much the same as if expensive buildings were erected without suitable foundations. This question of adequate foundations is one which should receive the careful attention today, and one which, if neglected, will do more than anything else to hamper the development of good roads, since great disappointment must arise when, within the course of a few years, it is discovered that the wearing surfaces which are now being constructed are so inadequately supported that they have given

*See Illustrations in Trans. Am. Soc. C. E., 1912, Discussion: Road Construction and Maintenance.

†Engineering News-Record, 80, 610, March 28, 1918.

no reasonable return for the cost incurred in building them.

An adequate return, therefore, for the money expended on any type of pavement or road surface is dependent, after the provision of a dry support, on the rigidity of its foundation. The necessity for strong foundations is emphasized at the present time by the fact that our street pavements and main arteries of communication are called upon to carry a heavy burden and a very large traffic, owing to the advent of the motor vehicle, more especially the motor 'bus and motor truck, the latter rapidly increasing in capacity to such an extent that it is recognized that means for regulating it must be considered.

Foundations may be differentiated, primarily, as those depending on the soil alone as a support, known as natural or subsoil foundations, and those provided artificially which are of many types.

Foundations, like drainage, are a local problem. To meet it satisfactorily involves a careful consideration of the environment of the road and the uses to which it is to be put. A foundation of a thickness of only 4½ ins. which appears to be satisfactory in the climate of southern California, would be useless in northern New York. A different thickness may be called for on a hillside and on a level and in low as compared to high ground. The nature of the subsoil or manner in which the road is supported from below will also have a decided influence, a weak support calling for a heavier foundation. Again, if the drainage is not entirely adequate, a heavier foundation will be demanded. Its character will also be influenced by the materials which are available for its construction. If these are of the best, the thickness may be less than would be desirable with inferior materials. Last of all the character of the travel to be carried must be given due consideration. If heavy motor trucks form part of it, proper provision, greater thickness and stability, must be made for their support.

Thickness of Foundations

In any case the foundation must be perfectly rigid and free from vibration, that is to say, it must have complete stability under the conditions it is called upon to meet and the loads which it will carry. No rule can be laid down for a thickness suitable for all conditions. In some instances, as on city streets, from 8 to 12 ins. or more of concrete may be necessary under the heaviest travel, while, as has been said, in California 4½ ins. in that climate, seem satisfactory for the main country highways.

According to the London Times of Feb. 13, 1913, the following depths of foundations have been used in London and in the neighborhood.

"In Bermondsey, for instance, while concrete 6 in. deep was formerly sufficient, the depth is now being made 9 ins. or even 12 ins. In Hackney foundations which were sufficient a few years ago are now found quite inadequate, and in new work the concrete is being made 50 percent thicker. The Hampstead surveyor considers that the life of wood paving has undoubtedly been reduced by one or two years, and it has become necessary to increase the thickness of the concrete foundations from 6 ins. to 9 ins. In Holborn cement foundations 12 ins. thick are being laid in places where a thickness of 6 ins. was sufficient ten years ago. In Paddington concrete from 10 ins. to 13 ins. thick is being used on wood-paved carriage ways where the thickness was originally about 7 ins., and in Westminster the specifications now used when new foundations have to be laid provides for 1 in. of floating and 8 ins. of concrete foundation instead of 6 ins."

The necessary thickness of foundations under the surfaces of our country highways will vary with local conditions, as will the determination of its character, whether it should be concrete, a Telford support or broken stone or gravel placed on the soil. With the increased construction of durable surfaces provision for proper drainage and adequate foundations must receive greater attention than they have had up to the present time and many of the failures on our country highways are due to deficiencies in these directions. To these deficiencies must be added the carelessness of contractors in carrying out work and lack of inspection on the part of state and local authorities. The best materials cannot give results commensurate with the increased expenditure incurred in using them unless the surfaces constructed are properly supported and drained, which is too often not the case.

There are but a few types of foundations which have been recognized as the result of service tests, as being satisfactory for road surfaces subjected to heavy travel, and some of these only under favorable conditions.

Portland cement concrete of sufficient thickness, properly proportioned and supported on a well-drained subsoil, is probably the most satisfactory foundation for pavements and road surfaces. Old waterbound macadam, which has been thoroughly compacted under travel, has also demonstrated its suitability, or a course of broken stone 2½ ins. or larger in size, put in place for the purpose, on a dry, firm subsoil, has given satisfactory results as a support for asphalt surfaces under particular conditions. Gravel surfaces, new or old, when in good condition, have also served.

All Public Engineers Should Support the American Association of Engineers.

To the Editor:

In reading the March issue of MUNICIPAL AND COUNTY ENGINEERING I came across your editorial dealing with the activities of the American Association of Engineers in connection with wages paid railroad technical engineers. May I presume to answer your query as to whether similar action could not be had on municipal and county engineers' salaries?

This question is already before the association, as witness an editorial on the subject in the March issue of the Monad (which is quoted below), and a letter addressed by the association to Mayor Thompson, of Chicago, and published, I believe, in the January issue of the Monad.

I am sure that Mr. C. E. Drayer, national secretary, who may be found at 29 South La Salle street, Chicago, Ill., will be glad to give any further information he has as to what is to be done in this matter.

The important thing now is for public engineers the country over to come to the support of the A. A. E. as the railroaders have. Here in Cleveland they are doing just that and are giving us their vigorous support in our railroad problem. Such co-operation is essential to the success of the association's efforts.

To the extent of my ability I shall be glad to be of any possible assistance in this matter.

Very truly yours,

512 Columbia Bldg., Cleveland, O. ERNEST R. TAYLOR.

The editorial from "The Monad," to which Mr. Taylor refers, follows:

"The Next Group Needing Organization Help

"As soon as the railroad program is well in hand, consideration of a program to include the problems of all other engineers in public service, particularly municipal, county, state and federal government, will be opportune. All who have given thought to the subject agree that the work involved in the field of the public engineer is of greater magnitude and more difficult than that in the railroad field. It includes not only the question of pay, but the placing of engineers in positions they should hold, the establishing of standards of efficiency and the supporting of the engineer in public service against the forces that are often found in combination to pre-

vent the realization of the high degree of service the engineer desires to render. Let us be thinking and girding ourselves for the work ahead.

"Organization is the only way."

(It is strongly urged that municipal and county engineers act on Mr. Taylor's suggestion "to come to the support of the A. A. E."—Editor.)

An Engineer's Thoughts on the Labor Situation

By Hugh W. Skidmore, Civil Engineer, Chicago Paving Laboratory, 160 N. Wells St., Chicago, Ill.

The civilized world is face to face with the labor question. The problem is indeed a practical one and cannot be solved by theory alone. We have felt this thing coming for sometime: thoughtful, far-seeing men of affairs have told us of the impending danger and have warned us that something must be done. Having been adequately forewarned, and having at least a fair understanding of some of the things which must be done, we now come to the moment of action.

Action must not be delayed and it must be decisive. Shall organized labor be dominated by Bolshevism and I. W. W.ism?

Gompers or Bolsherism

It is only natural that we should consider such a thing impossible in this free country, where labor, along with the rest of us, has so forcefully demonstrated its patriotic mettle during the time of stress. I believe organized labor will not submit to this vile influence. I am inclined to place considerable confidence in these words from the lips of Samuel Gompers in speaking of the Bolshevik element in labor union,—"It is from the activity of this radical element, the American Bolsheviki, that labor, organized for justice and right, has earned countless enemies and, indeed, suffered through the unfavorable light they have cast upon it."

"But the mental cobwebs of the past have been swept away by war. Organized labor in the United States will not be disrupted. Organized labor will fight with every means within its command the insidious propaganda the Bolsheviki are using to reduce the ranks of its members. Not only will organized labor protect itself against the contagion of Bolshevism; it will protect the republic."

Notwithstanding the fact that the president of Organized American Labor has expressed himself in so determined a fashion, the problem cannot be solved by labor alone; organized labor cannot rid the country of this pestilence unaided. No more can labor, working alone, hope to rectify some of its own more serious shortcomings without considerable delay and great cost to the public. The problem embraces too much that concerns the employer, that concerns us all, to be worked out entirely from the labor standpoint. Our social and economic fabric is of such delicate texture, is so closely woven and interwoven, that no one force may act entirely independent of the others; not without destroying the pattern.

Labor comes out of the war with much gained and likewise much to be done in order to retain what has been won. Wages have been uniformly and substantially increased, and it seems generally understood that present prices will obtain for some time to come; the voice of labor is heard in every discussion of vital questions—we no longer conceive of a conference group from which representatives of organized labor are excluded; in the majority of cases employer and employee understand each other better; and labor has a clearer knowledge of its own faults and their possible remedies. In the last two results will be found the means of retaining and enhancing the first two.

Labor Radicals

Under pressure of war conditions the bars have been unwittingly let down to such an extent that thousands of radicals have gained admittance into the ranks of labor unions. In many cases this radical element has actually assumed leadership. With the possibility of unemployment ahead the appeal of these propagandists becomes all the more potent.

Like a malignant disease which contains the germ of self-destruction, Bolshevism and I. W. W.ism would ultimately destroy themselves, because they are fundamentally wrong. Granting that this filthy epidemic (there is little if any difference between Bolshevism and the I. W. W.) should become so virulent that it would consume itself, or should even gradually wear itself out, imagine the damage and suffering that would be wrought while the course was being run. The case is not one for homeopathic treatment—an operation is necessary—the offending element must be completely eliminated.

Deport These Foreign Devils

There is no room in this country, nor in the world, for any institution that seeks a selfish and false end, that disregards the rights and property of others, that openly denounces and seeks to destroy the government, and last but not least holds as false the sanctity of the home. The weapons of this monster are malicious misrepresentation and suppression of fact, sabotage, thieving, rape and murder. Law, honor, justice, love and charity are not to be found in the Bolshevik code of ethics. This "red plague" must be stamped out thoroughly and at once. Deportation should continue until every last one of those trouble seekers and trouble makers is back where he belongs. The civilized world will find the task of dealing with these chaps much easier if they are segregated in the countries which bred them.

Manifestly, then, the first task which labor organizations must set themselves to, is this much needed housecleaning. But after the cleaning out, the house must be disinfected and put in order. In other words, there are certain methods and practices of which labor has long been guilty—which the public has considered the necessary evils of organized labor—that must either be adjusted or discarded entirely.

Exploiters of Wage Earners

The members of labor organizations must cease their humble acceptance of the dictation of unscrupulous and greedy officials. In so saying, I do not intend to convey the impression that all labor officials are of necessity greedy or unscrupulous. The members, themselves, must actually run their own organizations, they must see for themselves where their money goes—they must legislate and administer and stop being "legislated," "administered," and assessed to suit the convenience of a few, whose only interest in the advancement of the cause of labor is measured by the amount of personal gain available. In the past these grafting labor leaders—major and minor union officials—have been one of the chief causes of difficulty between employers and employees—their existence has long been common knowledge.

Labor Union Reforms

Labor unions must conduct their affairs in a businesslike manner. Petty haggling and scrapping between local organizations must stop. Agreements with employers must be kept, if the employer is to be expected to abide by his bargain. Strikes must not be called and arbitrated afterward. The sympathetic strike is one of the most intolerable and unjust acts that labor has been and still is guilty of. They are seldom justifiable and should, if ever, be ordered only as a last resort. If unions are to serve as employment clearing houses for the various trades, the requirements for admission into the unions must be raised and strictly enforced; worthless, inexperienced and unskilled workmen must not be sent out as first class artisans.

In short, labor unions must give the highest possible grade of service both to the laborers themselves and to the employers of labor. Labor rightly organized and properly operated be-

comes a powerful force for good in direct ratio to the justice of its intentions and fairness of its methods.

Obligations are Reciprocal

The cleaning of the house in which labor dwells will by no means solve the problem. Simultaneously with it must come some monumental changes in the attitude of the majority of employers toward the rights of the workers. They are human, they are fellowbeings. They desire and deserve the best of working conditions, good homes, clean amusement and above all a tangible interest in the things which their hands produce.

After all the question is a business proposition. The employer representing capital and invention provides the materials for production and the laborer furnishes the means of production—together they produce. Neither is independent of the other, their interests are one.

Analysis of the situation reveals the truth, and truth is fundamental. The engineer builds upon fundamental truth, builds for the comfort and welfare of humanity in general. The vision of the wide-awake engineer need not be stretched very far to bring into view the unlimited scope of his opportunity. With the inevitable readjustment, reorganization and reconstruction already on the way, the engineer will find his greatest chance to serve humanity in a manner that will add immeasurably to his standing among men in all walks of life.

Principles and Procedure in Classification and Standardization of Salaries of Railroad Professional Engineering Positions

By J. L. Jacobs, Consulting Industrial Engineer, Chicago, Ill.

(Editor's Note: This abstract of an address delivered at the recent Railway Engineer's Conference held in Chicago shows the trend of the times toward the standardization of engineering positions and the fixing of an adequate minimum wage for each position. The author's presentation is of interest to all engineers wherever, for the moment, employed.)

(1) *General Considerations*

One of the far reaching results of the world war is the creation among the industrial leaders of all sides of a desire to unite on the work of the industrial and social reconstruction. The policy of American industry in the future, is to be based on democratic cooperation as against the policy of autocratic exploitation.

This frank and full-hearted cooperation of all the human factors concerned is vitally essential to the success of any plan dealing with economic and social problems. With a determined endeavor to do justice to the greatest number, to remove causes of industrial friction and to develop the spirit of national service, there is bound to come about incalculable economic, social and political benefits to all.

The Classification and Salary Standardization Movement

The realization that the human element is the most vital factor in service and production, has brought nation-wide and intensive consideration to the problem of employment. An important result of this consideration has been the evolution of the movement, referred to as the classification and salary standardization movement. Employment classification and salary standardization has made great headway because through it there comes justice and fair dealing and better understanding and harmony, both of which are indispensable in this day of competition for efficiency and production.

It is up to the professional engineers to take a leading position in this work. The activities of the American Association of Engineers along these directions are noteworthy examples of what can be done in the direction of developing constructive thought and action with reference to the economic and social status and ideals of the engineering professional groups. There is nothing that can stop this positive movement. These activities must be the forerunners of nation-wide action through all the professional engineering groups.

Present Demoralizing Factors

Inequalities in salary rates for positions having similar duties and responsibilities; interpretation and readjustment of salaries and working conditions without definite and sound bases; lack of standards of duties, responsibilities and qualification requirements; multiplicity of misleading and unnecessary titles; inequitable and unsystematic practices concerning selection, assignment, promotion and other employment conditions—all these have a demoralizing and stagnating effect on employes, employers, and the community.

This constructive program contemplates not only the elimination of inequities and inequalities in the compensations and opportunities of employment but has for its objects the formation of sound and definite bases for the determination and regulation of salaries and employment conditions; the development of practical standards of service, duties and qualification requirements; the establishment of clear and uniform understanding of the obligations and advantages of employments; the introduction of definite procedures governing selection, advancement, promotion and retirement on the basis of merit and seniority; and detailed fact bases and organization necessary for effective administration of all matters of employment.

Justice for Railway Engineers

The work now under way by the group representing the railroad professional engineers in the setting up of standards and uniform salaries and employment conditions for professional engineering positions in the railroad organizations will be of great aid to the district railroad officials, to the railroad adjustment boards and other agencies and will give impetus for similar action on the part of other professional engineers and employers. As a result of this work there should be made available for the first time, equitable, clear and systematic bases of dealing with and settling problems of the relations between men in the engineering profession and the industrial world.

The establishment of uniform and fair standards for the regulation of salaries and employment conditions for professional engineers is particularly opportune because of some steps already taken by governmental departments and representative organizations of workers and industrial concerns. Regulations already established by some of the industrial, governmental and labor organizations and included in agreements between employers and workers of many industries and the labor policies established by a number of governmental agencies are good examples of the steps already taken to develop more equitable and uniform methods of compensating employes for services rendered.

(2) *Essential Principles*

Essential features and underlying principles for sound classification and salary standardization have been developed as a result of intensive studies, experiences and observations of employment situations in many services. Professional engineers and employers would do well to adopt the constructive method and principles that have been evolved in various industrial and governmental services and are considered by many to be the most significant development of the method to improve industrial and economic conditions. These essentials and principles are set out as measuring standards for the classification and standardization of the railroad professional engineering positions as well as for other professional engineering groups.

As the plan proposed for the railroad professional engineers measures up to these standards so will the broad purposes be attained. The program of service and standardization of all the professional engineers should be the program of the railroad professional engineering group and that program should include the following fourteen essentials:

(1) Equitable and logical basis for fixing and adjusting salaries in relation to duties and qualification requirements and cost and standard of living.

(2) Definite wage differentials for different positions based on special work and qualification requirements, location and other special employment conditions.

(3) Classification of positions into functional classes, all positions being placed into classes according to general character of duties and into grades according to responsibility and difficulty of work.

(4) Standard and distinctive titles for all positions having similar duties and work requirements.

(5) Definitions of duties and responsibilities for each position.

(6) Definitions of qualification requirements for each position.

(7) Definite and equitable plan for recognition of efficient service and seniority through periodic advancement—particularly applicable to the lower grade positions.

(8) Definite lines of promotion for employes in the various groups and grades.

(9) Definite regulations for the determination, adjustment and control of salaries and working conditions.

(10) Standards of service for use as a basis of advancement, transfer and increases based on efficient service and seniority.

(11) Basis for the establishment of co-operative relations and measures between employes and management to improve social, economic and industrial conditions.

(12) Definite plan of administrative machinery for insuring equitable and orderly handling of problems of classification, salaries, working conditions and other matters of mutual interest.

(13) Definite formation of effective and fully representative associations for studying, developing and advising on the industrial, economic and public matters which are of common interest and for mutual support.

(14) Definite proposals for the next steps in the improvement of the status of professional engineering and the development of positive methods and ideals for service and employment.

(3) *General Procedure*

The following general procedure could be successfully applied in connection with the broad program of classification and salary standardization for railroad professional engineering positions as well as for the other professional engineering groups.

(1) Establish cooperative relations with representatives of professional engineering groups and associations, employers, and governmental agencies with a view of obtaining common understanding, full-hearted consideration and support in the development and establishment of the standardization program.

(2) Determine the divisions of professional engineering groups and the order in which classification and salary standardization for the same are to be developed.

(3) Collect for analysis, information and data from reports and documents containing laws, rules and regulations and descriptions of the organization, work and qualification requirements of the positions under consideration.

(4) Collect for analysis, information and data on cost and standard of living, hours of work, and other working conditions for the respective positions by districts and for the country as a whole.

(5) Develop groups of occupations setting forth standard and distinct title designations, definition of duties and qualification requirements; character of occupations; and lines of advancement and promotion.

(6) Establish factors and standards for the determination of basic salaries and differentials dependent on educational requirements, cost and standards of living, working conditions, and special qualifications.

(7) Develop standards of service as a basis for selection, assignment, transfer and advancement according to service and seniority.

(8) Prepare code of regulations and conditions as part of the general standardization plan.

(9) Hold conferences with representative of engineering groups and employers with a view of obtaining suggestions as to changes in classification standards and factors, and approval of the general plan.

(10) Prepare regulations and procedure on the manner and method of applying and administering the standardization program.

Obtaining Proper Recognition of the Engineering Profession

By W. W. K. Sparrow, Chief Engineer, Chicago, Milwaukee and St. Paul Railroad, Chicago, Ill.

(Editor's Note: These excerpts from the conservative address of Mr. Sparrow, delivered at the recent salary conference of railway engineers in Chicago, would have been considered radical only a few years ago. Then only the chainmen dared express themselves freely while waiting for the transitman to set-up over the hub. Gradually those higher and still higher up have started speaking right out in meeting about engineers' compensation, hours, etc. With half an eye one can see that a new day for the engineer is coming; it is almost sun-up now.)

Cause and Effect

I think the training of the engineering profession teaches us the law of Cause and Effect and that to every action there is an equal and opposite reaction. Consequently there must be a cause for the lack of recognition and interest in us. Therefore, before prescribing a remedy, we must first ascertain the cause.

To me the answer to this question is largely our own lack of interest in affairs outside of our profession, and also our lack of organization and concerted action. The engineer, as a rule, is diffident and modest; he has stood aloof from and taken little interest or activity in matters of public and political importance and the activities of our societies and associations have been largely, if not exclusively, confined to technical matters within the profession and even in those affairs little or no effort has been made to bring to the attention of those outside of the profession the part that it has taken and is taking in the progress of the world.

I have stated that as a profession we have taken little interest in other than technical matters and as an illustration of how the profession suffers as a result of such lack of interest, I would call your attention to the Newlands bill, introduced in the United States Senate at the first session of the 64th Congress for the purpose of creating experimental stations in engineering, similar to the experimental stations already inaugurated in agriculture. The introduction of the bill was the result of the awakening which the war produced and which led to fresh and renewed activity among the advocates of federal support for technical and engineering research, which it was felt would greatly assist in the development of all industrial resources. The bill failed and I am sorry to say that its failure was mainly due to the lack of active interest on the part of the engineers and those interested in the development of our industries.

An Open Profession

Another contributory cause is, in my opinion, the absence with few exceptions of state or national regulation in the practice of the profession. In the majority of our states any one who so desires may start to practice the profession of engineering without let or hindrance. Our profession in this respect is in about the same position as the medical profession was one hundred years or more ago when any apothecary could practice medicine, just as any plumber can today practice engineering as a sanitary engineer. Everyone today knows that a doctor must be licensed by the state to practice medicine and

that before he is able to obtain that license he must be properly qualified. In England the social class is, or was, more distinctive than in this country, and there was, and is, unless the war has eliminated it, still a distinct line of separation between classes and the social class to which he belongs is distinctive of a man's position in life. Before the medical profession was subject to state license and when any "quack" could legally practice medicine, a doctor or "leech" as he was often termed, had little or no social recognition. In England today the medical profession has taken its place in society and receives the recognition of all, and the first step in placing it on the plane it now occupies was in requiring every one who practiced medicine to be licensed to do so by the state.

What Licensing Has Done for South African Land Surveyors

In South Africa land surveyors, or government land surveyors as they are known there, must be licensed by the state to practice. In transferring or subdividing land the deed or legal document must be accompanied by a plat giving the necessary information in a prescribed manner prepared by a government land surveyor. The plat and survey must be submitted to the surveyor-general's office, where it is checked and record made of it. No transfer, subdivision or plat of land has any legal standing unless the work is done by a government land surveyor and the survey passed through the surveyor-general's office. The qualifications of government land surveyor are high. He must pass a very rigid theoretical examination and if successful in that, a practical one. It requires about three years' hard work to qualify. The result is that the Cape Government Surveyor has regular fees which give him a better return than the average engineer in that country and his profession, which is only the kindergarten of engineering, has received recognition and standing both in that country and out of it. I have heard it said on more than one occasion, and I believe with truth, that nowhere has the practice of land surveying been brought to the standard of South Africa.

Education Too Narrow

A further cause, I believe, lies in our education, which I think has been too much along technical lines and not enough attention paid to education of a general nature. The result is that the outlook and view of the young engineer leaving college is inclined to be too narrow and technical and he is often not sufficiently well informed upon, or his interest aroused in questions other than those of a technical nature.

Three Prime Requisites to Greater Recognition

Summarizing what I have said, my views as to the three prime requisites to obtaining greater recognition for the Engineering profession may be stated as follows:

1—Organization
2—Licensing
3—Broader education, interest and activity in other than purely technical matters.

Trade Union "Methods" Opposed

A letter in a recent issue of the News-Record advocated an Engineering Union affiliated with the American Federation of Labor, and I desire to state clearly and beyond possibility of misunderstanding that I am unalterably opposed to any organization along the lines of the labor unions, or perhaps it will be more correct to say to the methods adopted by those unions, as it is not the organization, but their methods, to which I am opposed. The question of organization is receiving the thought and attention of many engineers and we must be quite clear and definite as to the kind of organization we want.

It would be outside the range of this discussion to enter into an argument upon the merits and demerits of the struggle between labor and capital, but I am convinced that the engineering profession as a whole would never countenance the adoption of methods destructive to our economic welfare. Strikes and lockouts are economically unsound and an extensive application of the movement must inevitably lead to economic disaster. No matter what the argument, genuine or specious, made in support of the use of the strike threat, the cumulative result is the undermining and destruction of governmental authority and industrial enterprise. Our profession is constructive, not destructive, and we cannot countenance for a minute the adoption of such methods. There are other objections to the methods of trade unionism, one of which is that it destroys individuality and initiative and tends to reduce the efficient to the level of the inefficient.

For a League of American Engineers

It is not, in my judgment, necessary in order to secure recognition of the qualifications and accomplishments of the engineering profession and readjustment of the compensation paid, so as to be adequate for the services performed in comparison with and in relation to the compensation paid to others, to resort to or adopt the methods of organized labor, and to do so would lower, instead of raise, the standards of the profession. Unity and concerted action are, however, necessary, and what I would like to see brought about would be an organization known as the United States Association of Engineers, similar to the United States Chamber of Commerce, which is the national organization of the business men of America, and which would embrace all branches and existing organizations, civil, mining, electrical and mechanical. Such an organization would have for the different branches of the profession, its section devoted to technical discussion and research; its section devoted to the promotion of the economic welfare of the engineer; its section devoted to matters of political and public interest, as for example, education of public opinion to the advantage and desirability of having engineering representation on public bodies having to deal with questions and problems involving engineering knowledge and experience, the appointment of engineers to public positions, involving similar knowledge and experience, the adoption of a National Department of Public Works and many other similar and important questions. Such an organization, with its supreme, or chief executive council, made up of representatives of all branches of the engineering profession, would command the attention and respect of the nation.

This may seem to many an impracticable dream, but today when we are dealing with a League of Nations why not a League of the American Engineering Associations and Societies? The framing of such a constitution ought to be simple compared to that of the League of Nations. Nothing, of course, can be accomplished without a start, and as a start we have the American Association of Engineers, the only engineering organization I know of in this country devoted to other than technical matters. Let us develop it and build it up along such lines that it will stand to the engineering profession in the manner that the Chamber of Commerce stands to the business men of America.

Some Good Advice Here

I am a railroad man and am speaking, I presume, largely to railroad men and, of course, that is the branch of the profession, which, as railroad men, we are most interested in. At the present time I do not belong to the American Association of Engineers. I have, with the conservativeness of the land of my birth, hesitated in joining until I felt quite satisfied that the objects and methods of the association were along the right lines. I have reached my decision and am going to send in my application for membership this month and shall urge, not only railroad engineers, but every engineer of my acquaintance, to join the association and lend a hand. We should not rest in the organization of railroad affairs until we see every railroad in the country with its chapter or division of the American Association, with sub-divisions over its entire system, each subdivision to have its own officers, reporting to the chief executive council for that railroad, which in turn would report to the railroad council of the national association. Let us invite the cooperation of our sister organization, the American Railway Engineering Association, and build up a nucleus of a national association, embracing all branches of the profession.

One Voice for the Whole Engineering Profession

While urging complete organization of railroad engineers, I do not want anyone to go away with that as the goal in view. A small organization of one section of the profession will not accomplish the desired result We must have an organization which, when it speaks through its duly elected representatives, will speak for the whole engineering profession of the United States. That voice will be heard and listened to. We railroad engineers can, however, set the necessary example and strive to organize the railroad section of the national association in such a manner that it will serve as an incentive to other branches of the profession to do likewise.

Whether for good or for ill, the individualistic age is almost a thing of the past. We have in the last ten or fifteen years seen some great changes, but the changes in the next ten or fifteen years will, I think, be much greater. It is not so very long ago when a man could beat his horse or his child as much as he liked. Today he cannot, and as an illustration of the restriction that is being placed on the individual, he has not, or soon will not have the privilege of abusing himself by drinking what he likes.

The movement of the day appears to be in the direction of organization by classes, and the engineering profession ought to be, and I trust is, alive to the movement. Therefore, let us invite the cooperation of all and use our influence in every direction to build up a national association which will embrace all branches of the profession and have as its object not only the advancement of technical research, but the economic, social and political welfare of the profession as a whole.

City and County Engineers Report Public Works Activity in all Parts of the Country

In the two latest issues of Municipal and County Engineering numerous letters have been published reporting construction activities in various cities and counties throughout the country. These letter have clearly reflected the optimism of local authorities and have reported specific plans and progress. A splendid construction year is now an assured fact. The present article gives reports from more city and county engineers on their plans for this season. Additional information of this sort, drawn from authoritative sources, will be published each business daily in the special daily reports issued by Municipal and County Engineering.

Chicago, Ill.—Bureau of Engineering

John Ericson, City Engineer, writes:

"The Bureau of Engineering of the city of Chicago has under contemplation the following work for the year 1919:

"Completion of Franklin-Orleans street bridge, total cost, $946,500.

"The foundation on the south side of the bridge is finished and work is going on on foundation on the north side.

"Completion of Wells street bridge, total cost, $1,450,000.

"Work on foundation on the north side of this bridge is under way. The entire bridge is estimated to be completed about August 1, 1920.

"New bridges on which work will be commenced in 1919:

Kimball avenue bridge, estimated cost	$ 70,000
Lawndale avenue bridge, estimated cost	50,000
Addison street bridge, estimated cost	175,000
Madison street bascule bridge, estimated cost	935,000
Twelfth street bridge, estimated cost	1,000,000
Twelfth street viaduct (east of river), est. cost	2,000,000

"There are a number of installations in connection with the water works, such as boilers, auxiliaries in pumping stations, etc., amounting to about a half million dollars, that will be done during the year.

"It is also contemplated to commence work on the new water tunnel in Western avenue and 73rd street, together with a pumping station to be located at 61st street and Western avenue, at a total estimated cost of about $3,000,000. This is, however, contingent on funds being available for this purpose, the appropriation bills not yet having been passed by the City Council.

"This is the principal work, so far as this Bureau is concerned, that is under contemplation for this year."

Pittsburgh, Pa.

N. S. Sprague, Chief Engineer, Bureau of Engineering, Department of Public Works, writes:

"The city of Pittsburgh proposes the following.

Sewer construction	250,000
Bridges	100,000

"The city has also under consideration a People's Bond Issue, amounting to upwards of $12,000,000, of which the principal items are as follows:

Street improvements	$1,500,000
Street repaving and resurfacing	1,000,000
Sewer construction	1,400,000
Bridges	500,000
Park Improvements	500,000

"This bond issue has been under consideration for several years past, and it will undoubtedly be voted favorably on by the public.

"There has been a decided demand for public improvements from every section of the city. The various boards of trade and other civic organizations are constantly requesting improvements which have been postponed on account of the great world war. This perhaps more than any other cause will tend to produce greater construction work than was at first anticipated. There is not now any problem of unemployment in this section of the country, but it is the duty of state, municipal and other political subdivisions to carry out large programs of public improvements to provide 'buffer' employment in this gradual change from a war to a peace bais."

Laconia, N. H.

Chas. A. French, City Engineer and Superintendent of the Department of Public Works, writes:

"It is proposed that a much larger amount of construction work, such as streets, roads, pavements, and sewers, etc., be undertaken this season than ever before, not only to make up for what was planned but not constructed during the war but also to give employment to those temporarily out of work on account of the readjustment necessitated by changing industries from peace to war basis.

"It is to be hoped that all may see the necessity of reducing the price of building materials to the lowest possible basis so as to encourage rather than discourage states and municipalities from undertaking public works. Freight rates on gravel, crushed stone and similar materials should be reduced if possible as well as the excessive demurrage charges on this class of material.

"It is the disposition of the authorities in this city to raise the necessary money for a large amount of public work all that can be carried through.

"The building of an $125,000 high school building is practically assured."

Flint, Mich.

Ezra C. Shoecraft, City Engineer, writes:

"Our 1919 construction program consists of the following, for which money has been appropriated, and which work is now under way:

18 miles of storm, water & sanitary sewers, value	$400,000
8 miles of pavements, value	400,000
500 sq. ft. of sidewalks, value	90,000
Water mains, value	75,600
Total construction cost	$965,600

"The work contemplated to be done, for which appropriation is asked:

Park improvements, which include swimming pools, comfort stations, wading pools, tennis courts, indoor baths, play grounds, etc.	$183,000
1 reinforced concrete bridge	16,000
1 2-arch reinforced concrete bridge	80,000
1 public market building	40,000
1 armory (State has already appropriated $60,000)	140,000
1 fire station	18,000
Total value of work contemplated for which funds are now asked	$477,000

Monroe, Utah

J. Lerue Ogden, Consulting and City Engineer, Monroe, Utah, writes:

"The Richfield City Council some time ago, in response to a very general desire of the citizens to have some street paving work done in the city this year, started investigations regarding costs of the same and at this date have begun actions that will secure for Richfield City a very considerable amount of street pavement before the winter of 1919 sets in.

"They have appointed Mr. H. E. Huddlesen of Salt Lake City as engineer and the following amount of street paving is planned:

"A strip 70 ft. wide is to be laid in the business district for five blocks or about 2,600 lin. ft., a strip 40 ft. wide is contemplated for 3 blocks, or about 1,600 lin. ft., a strip 36 ft. wide is planned for 18 blocks or about 9,000 lin. ft. Also a strip 18 ft. wide is to be laid for about a distance of 3,500 lin. ft., all told making some over 75,000 sq. yds. being contemplated. All of this except the 18 ft. strip is to be enclosed in concrete curb and gutters.

"The City Council appointed April 9, 1919, as a day of election to determine whether the citizens are in favor of bonding the city for the sum of $60,000 to pay for the city's share of the work. At the present time, March 25, the outlook is very bright for an overwhelming victory in favor of the bond issue.

"The payment for the proposed work is to be made as follows: The state of Utah, in compliance with its policy of favoring and aiding work of this kind during the reconstruction period following the great world war, is to pay for an 18 ft. strip throughout the entire city limits on the state road which comprises all but 8 blocks of the work. On these 8 blocks Richfield City will pay for an 18 ft. strip. The remainder will all be assessed against the abutting property holder. Of course the city will pay for all street intersections outside the 18 ft. strip to be paid for by the state.

"The pavement will be either reinforced concrete or bitulithic, which will be decided after the bids from contractors are received.

"The labor situation in the vicinity of Richfield is very good, no considerable surplus being present and therefore this proposition is not the prime mover in the project. However, the city council and citizens feel that it will be an act of patriotism to furnish this labor at a time when such actions are being called for by the U. S. Government to help over the readjustment period, and no doubt surplus labor in other localities will be called upon to aid in the construction, thereby helping the cause of our Government in trying to furnish labor for the returning soldiers."

San Benito County, Calif.

W. A. Winn, County Surveyor, writes:

"We have made plans for improving about six miles of highway with rock macadam at a probable cost of $15,000, and expect to build several concrete culverts during the year, which is about all the permanent work in the county.

"In the town of Hollister they expect to install street lights by the electrolier system for about 3,000 ft. and possibly pave about 4,000 ft. with oil macadam."

Faribault, Minn.

F. W. McKellip, City Engineer, writes:

"The council is in favor of 'buffer' employment and will undoubtedly do considerable construction work later on. At present there is a shortage of labor and this taken in connection with the high price of materials and uncertain weather conditions in this climate at this time of year will tend to retard the construction plans. We feel that the work upon local improvements should be given to local men as far as possible. But a small percentage of local soldiers have returned.

"Petitions have been presented or are being circulated for about 2 miles of storm sewer, 2 miles of curb and gutter, ½ mile of paving. Plans are prepared for a 100-ft. 2-span concrete bridge, besides more than usual in the way of graveling and road construction.

"The building program never looked so promising but high prices are holding back the start. Some one will soon break the ice probably and they'll all fall in. A new bank building is the only one of any considerable size—balance dwellings."

McMinnville, Oregon

Robert W. Jones, City Engineer, writes:

"The construction work that will be undertaken during 1919 under my jurisdiction will be as follows: Hillsboro, Oregon, 25,000 sq. yds. concrete pavement. Amity, Oregon, 20,000 sq. yds. asphaltic pavement. McMinnville, Oregon, probably 20,000 sq. yds. pavement. Yamhill, Oregon, gravity water system, 6 miles pipe line and concrete reservoir, which will cost about $35,000.

De Queen, Ark.

L. G. Ferrel, City Engineer writes:

"There will be built 6 highways in this county aggregating about 100 miles of gravel highway at a cost of one-half million dollars. These districts have already been organized. One contract was let on March 27, and the others will be ready to let before May 1. Sewer district No. 2 will be built in the city of De Queen in the coming fall and winter at a cost of $25,000 and the water works system will be extended at a cost of $5,000."

Lynn, Mass.

W. L. Vennard, City Engineer, writes:

"Three large concrete storm drains together with necessary changes in present combining system of sewerage will be constructed this year in Lynn. This work will probably cost together with some pipe sewers and house drains $126,000. The large sewers will probably be done by contract. We are to build in addition to the sewers about $176,000 worth of paved streets, some of which will be concrete, others will be of asphalt and tarvia."

Du Page County, Illinois

Arthur L. Webster, County Engineer, Wheaton, Ill., writes:

"At a meeting yesterday, (March 22) the commissioners of the Buffalo Grove Drainage District, of Cook and Lake counties (Wm. Kirchhoff of Mt. Prospect is chairman) agreed to proceed with the work, which involves 25 miles of tile, 6 to 30 ins. in diameter, and three miles of open ditches. It will cost in the neighborhood of $150,000.

"The commissioners of Coon Creek Drainage District, (Albert McCue, Scc'y.) will sometime this summer let contracts for the balance of their work, which will consist of about 7 miles of tile work, 6 to 27 ins. in diameter, costing in the neighborhood of $30,000. In addition there will be two bridges to build, valued at about $7,000.

"The Rockford-Winnebago Drainage District of Rockford, Ill., (Wm. Jamison Rockford, Ill., chairman) expect to complete their work, consisting of nearly two miles of additional tile, 8 to 24 ins., in diameter. The contract for open ditch outlet and 30 in. tile awarded to Millard Carr of Marengo, Ill., and now under construction.

"The Wauconda Drainage District, Wauconda, Ill. (commis-

sioners not yet appointed), consists of about 4,000 acres and will be both tile and open ditch and will cost in the neighborhood of $50,000.

"The Wayne-Winfield Drainage District, (Edward Plane of Elgin, Ill., chairman) expect to start spreading the assessment for a drainage district to cost in the neighborhood of $15,000, requiring tile up to 24 ins. in diameter.

"There are a number of similar projects which are more than likely to be constructed this year.

"I firmly believe that it is the duty of all men in charge of construction work to do all in their power to see that work progresses without delay. Nothing will do more to quiet the unrest of the country than to get the wheels of progress in motion, and I feel that my class of work is of more than usual value, as it immediately increases production. I have employed two returning soldiers who were in my employ before the war, and I am paying each of them $25 more than before the war. I have lost one of my best men, a lieutenant, who will stay in the service with the sanitary engineering department of the army."

Brainerd, Minn.

R. T. Campbell, City Engineer, writes:

"It is my pleasure to inform you that the city of Brainerd, under the jurisdiction of its Water and Light Board, has practically completed plans for an entirely new water system. These plans were made by Mr. L. P. Wolff, Consulting Engineer, St. Paul, Minn. The cost of this improvement will amount to practically $250,000, and, as it is a bond issue and the vote of the people of the city of Brainerd is necessary, the outlook for the favorable passage of this bond issue is very good.

"Some street paving is in view, but as our streets will be pretty much torn up during the necessary construction work of the water system, I believe that it will be rather late in the summer before any paving will be done.

"The county of Crow Wing, of which Brainerd is the county seat, is now preparing plans for the construction of a new court house which will cost $200,000.

"With this amount of work in view, it is conceded that Brainerd will be quite busy this coming season with work of a public nature."

Plainfield, N. J.

A. J. Gavett, City Surveyor and Street Commissioner, writes:

"It is not definitely known what street improvements will be made this year, but there is a probability that three-quarters of a mile of concrete pavement, 18 ft. wide, will be constructed, also about 1¼ miles of brick pavement. In this connection there will probably be a number of storm sewers required, from 15 to 36 ins.; probable cost of storm sewers, $40,000."

Sedalia, Mo.

F. T. Leaming, City Engineer, writes:

"We are now at work on a district sewer to cost $8,000; contracts for brick paving already let (work started April 1), $50,000; brick and concrete paving contemplated, $30,000; sidewalks and curbing, $10,000; total, $98,000.

"This city will call an election in the very near future to vote a bond issue of $30,000 or more to construct a modern incinerator or destructor. The Special Rock Road District Commissioners will soon advertise for bids for the resurfacing of 7 miles with crushed rock and asphalt binder. Approximate cost, $65,000. This is a state aid contract. The Mayor and Council of this city are doing all in their power to create work and keep labor employed during the readjustment period."

Youngstown, Ohio

Ett S. Smith, County Surveyor, Mahoning County, Youngstown, Ohio, writes:

"I am in hopes the labor situation in this community will be a great deal better this year than it has been in the last two or three years. The scarcity of labor has been a great handicap, and on that account much important work has been delayed up to this time. The outlook now is very encouraging and we are preparing for a large year's work, including 30 miles of new road construction, 28 miles of reconstruction and about 125 miles of surface treatment. We have already awarded the contract for 100 miles of surface treatment work and 8 miles of new construction, and are ready to advertise for bids for several more miles. Owing to the scarcity of contractors we do a large amount of our reconstruction work by force account. Our county owns two trucks, three 10-ton rollers, grader and scarifiers and other necessary equipment, with which we are able to rebuild and maintain quite a large mileage of roads each year. Our different types of construction include brick, concrete, bituminous and waterbound macadam. By surface treating the macadam roads we are able to keep them in a smooth condition. The roads that have very heavy traffic we resurface with brick over the worn macadam, and have found, after several years of experience, that it makes a splendid foundation for brick pavement.

"I hope that all officials who are in charge of building public roads and streets will go to the limit in the year 1919."

Durant, Okla.

L. Varner Stinson, County Surveyor and Highway Engineer of Bryant County, Durant, Okla., writes:

"The City Council, at the regular meeting of March 4, passed resolutions to pave Lost street and all the down-town alleys; this to be brick, on a concrete base, some 10,000 sq. yds. A petition is now being circulated, and at this writing seems to have a majority of property owners signed, requesting the Mayor and City Council to take the necessary steps to pave Evergreen street with rock asphalt on concrete, about 10,000 sq. yds. Elm street and Eighth avenue property owners will pave, but it has not been definitely decided with what class of paving. This will make the total yardage to come up in the immediate future something like 40,000 sq. yds. There are three or four more streets upon which the sentiment for paving is strong. All told, Durant will start the necessary proceedings to pave some 40,000 to 100,000 sq. yds. of street within the next year."

Columbia, S. C.

T. Keith Legare, City Engineer, writes:

"No definite plans have been made for our construction work during this year, but if the finances can be arranged it is proposed to pave four streets, amounting to $135,000, and construct a municipal abattoir and a market, costing approximately $115,000, also storm drains, costing approximately $8,000. This work has not been ordered by the City Council yet, but we hope that the matter will be settled at an early date."

Sioux City, Iowa

T. H. Johnson, City Engineer, writes:

"It is too early yet to give much of an idea what will be done here.

"We have no new work definitely outlined. We will probably do paving to the amount of $150,000; water works extension, $100,000; sewers, $40,000; bridges, $15,000.

"This may be very considerably increased, but at present writing there is nothing definite."

Rochester, Minn.

J. C. Utton, City Engineer, writes:

"Several projects were temporarily postponed during the period of the war, which we now anticipate will be resumed this year. We are preparing plans for from 50,000 to 60,000 sq. yds. of pavement, and one, possibly two, bridges, which we are confident will be carried through. With the cost of materials higher than in the pre-war period, there will no doubt be some hesitancy upon the part of the property holders in encouraging building. Admitting that the buying capacity of the dollar of today has declined, it is only by investment that it brings business, and good business means prosperity, which is what is needed at this time to promote optimism for the

future and to provide employment for the deserving unemployed."

Madison, S. Dak.

"Charles A. Trimmer, Consulting Engineer, writes:

"We have carried over from last year the following work: Lake Moody County joint ditch No. 1, total cost approximately $150,000, work about 50 percent complete; Lake County ditch No. 6, total cost approximately $40,000, work about 30 percent complete; Lake County ditch No. 12, total cost about $40,000, work about 75 percent complete.

"Since January 1 we have let contract for one job, Lake County ditch No. 20, to cost about $7,000.

"On March 24 we will open bids for storm and sanitary sewers for the city of Madison, estimated cost $37,000, and on March 25 will open bids for Lake County ditch No. 15, estimated cost $55,000. We also expect to open bids in the near future on Lake County ditch No. 13, estimated cost $140,000.

"Contract will also be let this year for about 50,000 sq. yds. of paving in the city of Madison.

"Petitions are being circulated for two additional county drainage jobs to cost approximately $20,000 and $40,000, which work will probably be ready for bids about July 1."

Grand Rapids, Wis.

A. T. Thompson, City Engineer, writes:

"Proposed construction work for the city of Grand Rapids for the season of 1919 is as follows:

"Reinforced concrete on Lincoln and Fifth streets, 5,730 sq. yds; reinforced concrete on Eighth street, 5,224 sq. yds.; reinforced concrete on Oak street, 8,516 sq. yds.; reinforced concrete on Third avenue, 5,294 sq. yds.; brick on concrete base on Grand avenue, 4,800 sq. yds., and approximately one mile of sewer laterals will be constructed this season."

Spencer, Iowa

"W. L. Fahey, City Engineer and Engineer of Clay County, writes:

"Spencer is going to do its share during the period of readjustment and has mapped out a comprehensive program toward that end. Plans and specifications are now being prepared for about 6½ miles of paving and the necessary curbing, guttering and other incidentals. Plans and specifications are also being drawn for sewers to cost about $40,000 and water mains to cost about $10,000.

Considerations Affecting Design of Heavy Traffic Highways in Ontario

By W. A. McLean, Deputy Minister of Highways, Toronto, Ontario

The motor truck as a means of transportation has come into recent prominence through its use for war purposes, through its application to freight transfer between adjacent cities and towns and over routes from 50 to 150 miles in length. Indications are many that, coupled with roads of adequate strength, the motor truck will become an ever increasing factor in this regard. Giving evidence before the Railway Commission of Canada in regard to freight rates, it was recently stated by railway officials that the influence of motor trucks on local freight adjacent to large cities is very great; that in certain cases steam railways now receive very little local freight within a radius of 50 miles from large cities having systems of good roads adjacent to them, as it is handled by motor trucks.

Motor Traffic Leads to Stronger Highways

Just as railways were compelled to use heavier rails and increased strength of roadbed to carry heavier trains and engines of the Mogul type, so will it become necessary to build stronger highways to serve the traffic of heavy motor trucks, particularly on main lines between cities and radiating from large centers of population. The wear from comparatively light and rapid traffic of passenger vehicles is first apparent on the road surface. Heavy trucks, on the other hand, while requiring durable surfaces, demand proportionately durable foundations. Heavy motor traffic has a shattering effect on weak foundations. The depth and strength of foundation is a primary consideration in providing roads which will give the motor truck freedom to enter the field of freight transfer to the extent to which it is economically possible.

The cost of constructing roads is largely in proportion to the depth of stone required. The necessary depth of stone will depend largely upon the character of the sub-soil over which the road is laid—the safe bearing pressure of the soil; and upon the maximum weight of loaded trucks permitted to use the road. The maximum weight of truck is a controllable factor, and should be fixed by regulation.

With unlimited funds, roads can be built which will sustain unrestricted traffic. But funds available are limited, and it is therefore necessary that reasonable standards be fixed and strictly enforced; and that roads be then designed for these conditions.

A reasonable maximum weight of truck should be determined; one which will serve the greater proportion of commercial needs. It is not good business judgment to spend large sums to build roads to the standard of a few trucks of excessive capacity. Trucks of excessive capacity should be prohibited. And regulation is particularly desirable with respect to roads of minor importance, and at seasons of the year when all roads are weakened by moisture and frost.

Bearing Pressures of Soils

Dealing with roads of the broken-stone or macadam type, the maximum load which a road should carry depends in the first instance on the strength of the sub-soil. There is much variation in the supporting strength of different soils, and under different conditions of moisture and climate. Thus "clay" may vary from hard-pan to clay loam; and a dry clay will support a much heavier load than when wet.

Safe bearing pressures of different soils have been determined in a general way for masonry structures. Expreimental investigation with special reference to road surfaces would no doubt develop useful data; but in the absence of more direct information, the bearing pressures adopted for the present purpose are those of the general Bridge Specifications of this department, viz., gravel, 8 tons per sq. ft.; compact sand or firm clay, 4 tons per sq. ft.; clay moderately dry, 2 tons per sq. ft.; wet clay, 1 ton per sq. ft.; quicksand or wet, yielding soil, ½ ton per sq. ft.

The Road Foundation

A concentrated wheel-load is carried downward through a broken stone crust to the sub-soil, at an angle which, it is estimated, diverges outward at about 30 degrees from the vertical. Thus, the effect of the "macadam" crust is to distribute the wheel-load over a greater area of sub-soil; this area increasing with the depth of the stone crust. The depth of stone in excess of the layer needed for immediate surface wear is therefore regarded as tho road "foundation." It is the layer of stone artificially laid over the natural sub-soil to the depth necessary to sustain an unyielding surface.

Weight of Vehicles

The maximum weight of vehicles (apart from the well recognized influence on bridges) thus largely determines the depth of foundation necessary on a given road—the depth of foundation varying also according to the nature of the sub-soil, and particularly in northern climates, the season of the year during which heavy vehicles may use the road. The constant passing of many light vehicles will, it is true, influence the foundation, and to meet this condition a certain "mass" is required; but a very few heavy vehicles may shatter an insufficient foundation and thus destroy the entire construction. It is necessary, therefore, that the engineer should know whether the maximum load is to be 6 tons, 10 tons, 15 tons, or 20 tons; particularly the maximum load concentrated on

one axle or one wheel; and also the width of tire on which the maximum load is concentrated.

Commonly, a motor truck, itself weighing 5 tons, can carry a load of 7 tons, making 12 tons in all. Two-thirds, or 8 tons is on the rear axle; one half of that load, or 4 tons, is on each rear wheel. The disruptive effect of this load on roads of light construction is very great—particularly in wet seasons.

Steam trucks, with steel tires, in some cases corrugated, are now in occasional use. As an instance, a 5-ton steam wagon in running order with fuel and water weighs about 6 tons, 10 cwt., with about 2 tons, 15 cwt. on the front axle and 3 tons, 15 cwt. on the back axle. Practically all the load would come on the back wheels, so that when loaded with 5 tons the actual weight on the back axle would be 8 tons, 15 cwt., or over 4 tons, 7 cwt. on each rear wheel. Motor trucks carrying 15 tons and weighing in all about 30 tons, are being manufactured.

Military experience will probably indicate the most desirable type and weight of truck for future industrial purposes. The great majority of trucks used by the French armies weigh 3½ tons empty, and 7 to 8 tons loaded. This standard, applied to road construction generally, would effect a great saving in cost as compared with the maximum of 15 or 20 tons which unrestricted loading will involve. If military preparedness demands provision for heavy artillery loading of 20 tons (and the tendency is still upward) a more moderate standard should be enforced with respect to the great network of purely agricultural and industrial roads which cannot be so built without imposing an unnecessary financial burden.

Thickness of Road Crust

The accompanying schedule, see Table 1, is drawn up with a view to the traffic law of Ontario, which permits a maximum load of 12 tons, or 4½ tons on one wheel; and a maximum pressure of 650 lbs. per in. width of tire. The general assumptions are: That two-thirds of the weight of the vehicle and its load will be carried on the rear axles; that wheel pressure is transmitted downward at an angle of 30 degrees from the vertical; that the various types of sub-soil will safely carry the pressure indicated at the head of each column; that the road crust is solely of broken stone or macadam construction.

From this schedule it is evident that 12 tons is the maximum load which can be carried without producing an excessive tire pressure; that there is little difficulty in providing for a 12-ton load on gravel, compact sand, or firm clay; that clay only moderately dry requires a crust approximately 10 ins. in thickness; that 12 ins. will take care of a 6-ten load on wet clay; but that 16 ins. would be required for a load of 12 tons (a condition which could probably be taken care of by a Telford base and broken stone surface having a total depth of 12 ins.). In the case of quicksand and wet, yielding soil, it is evident that special drainage or other special construction is necessary to meet the needs of any but a light load.

As clay is a soil which has very largely to be considered, its drainage and climatic conditions are evidently important factors, as indicated by the difference in depth of crust requred by a moderately dry clay and one which is wet.

TABLE 1—REQUIRED THICKNESS OF MACADAM ROAD CRUST TO TRANSMIT AT AN ANGLE OF 30 DEGREES FROM THE VERTICAL, SAFE BEARING PRESSURES TO SUBGRADES OF VARIOUS SOILS

650 lbs. per inch width of tire up to 12-in. tire.

Weight on vehicle, tons	Weight on rear wheel, tons	Width of tire, inches	Depth of stone in inches: Gravel, 8 tons per sq. ft.	Compact sand or firm clay, 4 tons per sq. ft.	Clay moderately dry, 2 tons pounds	Weight per inch width of tire, per sq. ft.	Wet clay, 1 ton per sq. ft.	Quicksand or wet, yielding soil, ½ ton per sq. ft.
3	1	3.07	650	2.33	3.74	5.98	9.05	13.40
6	2	6.15	650	2.63	4.87	7.92	12.25	18.30
9	3	9.21	650	3.16	5.65	9.20	14.40	21.80
10	3 1/3	10.25	650	3.23	6.10	9.60	16.20	24.80
12	4	12.00	666	3.46	6.10	9.60	16.20	24.80
15	5	12.00	833	4.20	7.26	12.00	18.60	28.20
18	6	12.00	1000	4.90	8.26	13.50	20.82	31.50
21	7	12.00	1166	5.48	9.20	14.65	22.50	34.60

Shearing Forces

Self-propelled gasoline motor and steam trucks, in addition to their heavy concentrated load affecting the foundation, have the further disadvantage of exerting a strong shearing force transmitted to the road surface by the driving wheels, so that their use demands not only a heavy and expensive foundation, but an especially durable surface as well. Legislation limiting extraordinary traffic of this description is justifiable, in order that a large increase in the cost of roads may not be necessary to serve the requirements of a few vehicles. Such limitation at the present time forestalls the introduction of unnecessarily heavy vehicles, and avoids cases of individual hardship. Width of tire alone will not solve the difficulty, as, owing to the necessary camber of the road surface, excessive width places the load on the edge of the tire. Should investigation justify it, a less weight than that now permitted in Ontario would be most desirable in the interest of road maintenance.

While limiting loads for Ontario have been fixed as previously stated, it will be desirable to observe carefully the future trend of commercial traffic in order that, if possible, the maximum load may be still further reduced. In 1917 there were registered in Ontario 4,929 motor trucks. Of these, nearly 75% were classed as one-ton or less; over 97% were 3½ ton or less, or within the general military truck standard; while less than 3% were 4-ton and upwards.

A considerable increase in motor truck traffic appears probable after the close of the war. At the present time in Ontario 1 vehicle in 17 is a commercial vehicle; while in the eastern manufacturing states, 1 vehicle in 6 is a truck. Growth of motor truck traffic to the latter proportion will undoubtedly create the need for stronger foundations, particularly on inter-urban highways; and over certain qualities of sub-soil the use of concrete in place of ordinary broken stone or Telford base, is strongly indicated.

The foregoing data and discussion are from the 1917 annual report of the Ontario Department of Highways.

Tamping Cheaply With Home-Made Compressor Outfit

In order to save the cost of a new air compressor, at $500 or more, the San Francisco-Oakland Terminal Railways decided to rig up an outfit, using some old railway compressors.

The idea was carried out by mounting a battery of six 11-cu. ft. capacity pumps on a truck.

The actual capacity required for the two Ingersoll-Rand tampers used is only 32 cu. ft., but double capacity was installed because the old machines were not good for continuous service at more than 50 per cent. loading. These tampers have proved particularly successful in tamping heavy special work. On this railway the machines have allowed six men to do the work which formerly required sixteen. Of the six men one is stationed to flag vehicles while another handles the connection to the trolley wire, leaving the remaining four to do the tamping.

With labor at $2.50 a day the relative costs are: Air tamping, $15; hand tamping, $40; a saving of $25 a day. The tampers paid for themselves in ten days. These tampers are also used for flat tamping of ballast in advance of concreting. They are fitted with chisels when wanted for clipping concrete and cutters when used in stripping asphalt.

EDITORIALS

To Promote Interests of Public Engineers

The public engineer is to be the chief beneficiary of the labors of the American Association of Engineers during the next twelve months. The annual convention of the Association was held in Chicago on May 12 and 13 and at that convention the executive committee of the Association was instructed to appoint a committee of three or four men to promote the non-technical interests of engineers in public service, including those employed by the federal government, the several states, municipalities and counties. Stated in plain language the object of this movement is to increase the compensation of engineers in public service and to lengthen their tenure of office.

Public engineers should now do all possible to help themselves as they are to be so greatly helped by the organized efforts to be put forth by the Association. Readers of this magazine are familiar with the work the Association has done recently on behalf of technical engineers employed by railroads. A conference of such engineers was held in Chicago to adopt a minimum salary scale for the various grades of engineers recognized by the conference and this scale was submitted to the United States Railway Administration with every likelihood of early adoption or, at least, substantial recognition.

Engineers in public service may confidently expect the Association to call a similar conference of public engineers, or groups of such engineers, when the right time arrives.

The Association is looking for suggestions and they should be freely offered. The Association is asking this question: "What can we do to help the engineer in public service?" The engineer should not fail to answer this question in his own way and in accordance with his own views. Letters on this subject addressed to the editor of this magazine will be promptly brought to the attention of the proper officials of the Association. Some of the letters so received will be published in this journal as it is our aim to stimulate discussion on this point to bring out all shades of opinion and to assist in getting all constructive suggestions on record as promptly as possible.

The public engineer should immediately apply his mind to this problem for nothing in history has so closely touched his vital interests. Here is a chance for him to assist in thinking out a plan for increasing his salary and the security of his position. Every public engineer who reads this magazine should at once think this matter through to the point where he is ready to propose a plan and to recommend procedure to make the plan effective. Let us have a letter embodying the ideas of the individual reader.

The editor has been a close student for years of all matters affecting the welfare of engineers and his sympathetic interest will not be questioned. Perhaps a few suggestions will, therefore, be accepted in the friendly spirit in which they are offered.

In writing an answer to the question: "What can the American Association of Engineers do to help the engineer in public service?" the correspondent should, above all else, stick to the text. If the reader has access to file copies of any engineering magazine published since 1875 and will look them over he will find that for nearly a half century engineers have written a very great deal on this compensation question. Nine-tenths of all such writings have been elaborations of the obvious. Stating the obvious fact that engineers are underpaid the various generations of engineers have most solemnly proceeded to prove it, digressing ever and anon to feel sorry for themselves. The futility of such discussions has been amply demonstrated. Start with the undisputed fact that the engineer in public service is underpaid and then state what you think should be done about it. For example, if you think engineers should become affiliated with labor organizations by all means say so. The editor is emphatically opposed to such affiliation, but if this discussion is to be of any value all shades of opinion must be frankly and vigorously expressed. While we do not favor affiliation with labor organizations our respect for the man who does favor that course and defends his views is much greater than it is for the man who has no plan to propose yet rambles all over the place in endless discussion. Labor organizations have their place, as all the world recognizes, but it would be a mistake, in our opinion, for engineers to go at once from one extreme to another. The editor purposely refrains at this time from expressing his opinion as to what should be done; of much greater importance is it to learn what engineers think should be done.

In discussing this matter it should be kept in mind that questions of definition are relatively unimportant. Some feel that the engineer is not properly appreciated by the public because the word engineer has been so widely and so loosely applied. Quite likely that is so but please bear in mind that the courts have defined the word in various states and the public has its own ideas which are not easily changed. If all engineers could agree on a definition of the word engineer, which they cannot, it would take generations to get the public to adopt it. And at that time the engineer might be, and probably would be, as poorly compensated as he is now and always has been. So let us keep off the subject of definitions of the word engineer.

Another thing that has been greatly overworked is that intangible something called "the dignity of the profession." Ideas of dignity differ. It is well to recall the Indian who, arrayed in his war paint and a white man's two-gallon silk hat, and little else, fancied that he presented a dignified appearance. The engineering profession has a dignity that approaches the majestic but this is in spite of and not because of inadequate compensation. If the engineer's dignity interferes with his efforts to obtain proper compensation he should revise his idea of dignity. Very little of value can be said of such an illusive quality as dignity in this purely business matter.

Still another thing to remember is that this movement is intended to benefit the man who is now an engineer and who expects to remain an engineer. If any man has ideas on how to get out of the engineering profession let him retain them for expression in a

discussion on that subject. Engineers as individuals are becoming farmers, merchants, salesmen, bankers, etc., but however much they may prosper in the change cuts no figure in this case. Our interest, and the interest of the Association, is in the engineer who remains in the engineering profession rather than in the one who leaves it or who flits about in a twilight zone.

These suggestions are offered in the hope that they will emphasize the imperative importance of being specific and of going straight to the point. Do not trifle too much with corrollaries. The engineer in public service is not properly compensated and he loses his job altogether too often. Now what do you propose doing about it? That is the question.

Is There a Propaganda for High Prices?

The average citizen is becoming somewhat cautious about accepting as true any sort of argument vigorously set forth and consistently maintained. He is inclined to regard everything of that sort as some species of propaganda calculated to lead him where somebody wants him to go. This is a natural reaction from swallowing whole everything offered during several years of war. From being too credulous he has become too skeptical; where he formerly believed nearly everything he now believes very little. This is all very well illustrated in the case of the present prices of materials used on construction work. There have been open charges of profiteering brought against the material men. These charges have been made by governors of states and by obscure citizens. It is all part of the prevailing suspicion about the other man's prices being too high.

Attempts to quote the history of price performances in similar periods following other great wars and arguments that because labor is high and everything else is high the prices of construction materials must also be high, have alike been regarded by many as merely so much propaganda. But little by little, all too slowly, citizens, officials and entire communities are finally becoming convinced that these prices are not too high and construction is proceeding in such communities.

In Illinois there has been much well advertised suspicion of prices. The report of the Dailey Joint Legislative Committee that has been investigating the cost of production of building and construction materials needed in the Illinois post-war reconstruction work was made public on May 7. This report was the result of weeks of investigation during which a great many witnesses were examined. It was commonly supposed that the committee would be able to prove that prices are needlessly high and thus force them down. In view of all these facts the following quotation from the conclusion of the report is most illuminating:

"We are driven to the inevitable, logical conclusion that existing prices will not decline materially, and that those prices express a new and substantially permanent level upon which present and future business must be conducted.

"We believe it to be our duty as public officials to advise the public not to delay building projects in the hope prices will come down materially. We do not believe they will.

"All contemplated buildings, homes and improvements should be started now. Reconstruction can only be accomplished in its real sense by every citizen subscribing to the doctrine 'Buy now, build now.'"

It is to be hoped that the results of this Illinois investigation will be accepted at full value elsewhere as they have been in Illinois. The state has awarded many miles of road contracts at this writing and many more are in prospect.

The searching Illinois investigation just recently concluded amply demonstrates that there is no propaganda under way to keep the prices of materials up. This ought to be the last hurdle for the construction industry.

One of the Things That Hurt Engineering

A man who has grown old and prosperous in the practice of engineering was recently discussing some of the things that hurt engineering as a vocation. He expressed strong disapproval of one practice that is harmful to engineers and engineering and even went so far as to assert that it has ruined the business of consulting engineers in a certain state in the middle west. He referred to the taking of consulting work by the members of the engineering faculties at state engineering colleges. Of course, this is not a new practice.

The practice is not wholly bad for the teacher needs to keep in touch with practical affairs and this requires some work in the field. This has always been the justification of the practice and is all right as far as it goes. The fallacy involved in this argument is that the faculty man who acquires the outside experience nearly always does so on time belonging to the students. The faculty man is paid by the state, presumably for teaching, and it is easy to understand the dissatisfaction caused among engineers not so paid who must compete with the state employee. Perhaps the most serious aspect of the matter is that the teaching is left to an assistant while the professor goes after the fees. The engineer who was commenting on this practice says the cure for it is to have all fees so earned paid into the college treasury.

The Newspapers and the Business Press

The newspapers and the business press are, in a sense, competitors. They compete for the time the public spends in reading. It is well to draw a distinction between the newspapers and the business press. The former need no definition but do not confuse them with the latter. The business press includes the professional journals, technical periodicals, class publications, vocational mediums, etc., as they are variously termed.

The newspapers and the business press are on good terms. Each needs and uses the other. There is ample room for both. But, years of observation have convinced us that much time now spent in reading the newspapers should be devoted to the business press. Let any man ask himself what of value he has obtained from his newspaper reading since the signing of the armistice. He has obtained much of value, of course, but how much for the time expended? How much of value that he has obtained would have been lost to him by cutting his newspaper reading time in half? Not much. It is a stimulating and time saving exercise to see how quickly one can read a newspaper without missing an item of essential news. Today a rumor, tomorrow a denial; the time spent reading each is wasted in the end. Would it not be better for the business or professional man to cut in half his time spent in reading newspapers and to use the salvaged time in reading his business papers? Those who have tried it answer this question in the affirmative.

Design and Construction of the Monolithic Brick Road South of Seneca, Ill.

By A. H. Hunter, District Engineer, Division of Highways, Department of Public Works and Buildings, Peoria, Illinois

Illinois was keenly alive to the value of highway improvement previous to the passage of the Sixty Million Bond Issue. Even before our regular state aid came into existence, many townships and counties had expressed a willingness to proceed with improvement of roads of local importance. Actual construction, however, was not possible until ways and means had been devised to take care of the financing. With the advent of state aid, which began actual construction in the summer of 1914, it was financially possible to take up road building on roads of county importance. In cooperation with the county, aided in many instances by townships or local support, the State Highway Department of Illinois was able to improve many roads of this character.

The knowledge that Illinois is a prairie state no doubt carries with it the implication that highway building in the state would be free from serious grades or faulty alignment. Generally speaking, this is true, but naturally enough those first sections designated for improvement by county boards were those presenting the most difficult problems locally. The writer has in mind several sections in the vicinity of the Illinois river which afforded opportunities for reduction of grade and improvement of the alignment. The problems encountered, together with methods of surface construction, can probably be best described by referring to one particular section which is fairly representative of this class. I have in mind the state aid road at Seneca, LaSalle county. Generally speaking, this work consisted in improving with 15 ft. monolithic brick, 1¼ miles of winding road which extended south from the south end of the Illinois river bridge at Seneca, up the south bluff to the prairie country beyond.

Selection of the Material of Construction

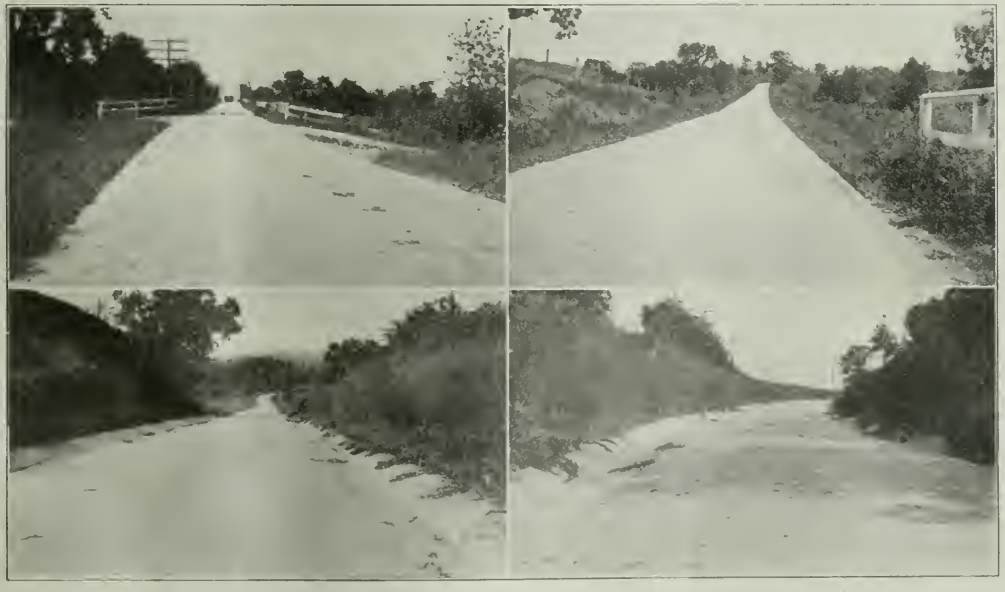
Before entering into the details of construction, I wish to state a few facts that lead up to the choice of surface. In a nearby gravel pit was found material suitable for use in construction of base for brick roads. Located in this same county is also to be found one of the largest paving brick plants in Illinois. This local situation, together with a local preference, prompted the County Board in specifying brick as the type of improvement desired.

Line, Grade and Sections

Early in the spring of 1916, surveys of the existing highway were made which in turn were used in the preparation of plans and estimates. This original survey followed the existing road, which was narrow, crooked and had a center line profile which indicated a maximum grade of 12 to 13%. In the first plan prepared, no relocation or change of alignment was considered other than improvement of the turns by standard circular curves. Again any radical change in alignment would necessitate right-of-way adjustments, which, unfortunately, our department was unable to undertake at that time.

The old grade being excessive, our plans projected a new maximum grade of seven per cent. (7%). This meant very heavy excavation on the hill. A total of more than seven thousand (7,000) cu. yds. was to be moved between stations 18 and 25. This material to be utilized to advantage in raising and widening the fill section near the Illinois river. The portion beyond the hill represented no unusual features, only the usual requirements for good surface drainage being required.

As provided in the preliminary resolution, a brick surface was planned. To meet the requirements, three standard sections were employed; one for the prairie country, another for the hill and a third for use in the fill in the vicinity of the Illinois river. The three cross sections are here shown.



VIEWS OF STATE AID BRICK HIGHWAY SOUTH OF THE VILLAGE OF SENECA, ILLINOIS.

Top Row: Surface of Brick Pavement. Also shows Guard Fence with Illinois River Bridge in Distance. This View just South of Heavy Fill Section where Protection to Traffic is Necessary—View on the Relocation with Hill in Distance. Note Portion of Guard Fence at Change in Alignment. Bottom Row: View on 7 Per Cent. Grade on Hill, showing Combined Curb and Gutter —Another View on Hill Section, showing Heavy Cut Section, Pavement and Combined Curb and Gutter.

The Hill Portion of the Road.

All work was planned as monolithic construction except in the cut on the hill. It was undesirable to plan earth ditches there, as such would be uneconomical on account of the large volume of earth excavation. Also, the hill having a 7% grade must be protected against wash in the side ditches. For these reasons, a gutter section was adopted. The 18 in. gutter on either side was to provide protection from the water. At the same time, it increased the width of pavement, really making available for traffic 18 ft. of improved surface.

Due to construction difficulties, this hill portion was planned as semi-monolithic or sand-cement bed. This type of improvement was preferred, due to simpler features of construction, the main reason being that no room was to be had in the cut for placing and culling of the brick, an all-essential operation for first-class monolithic work. By using the sand-cement bed, the base and gutters could be constructed in advance of the brick surface. When base and gutters were sufficiently hardened, brick could be stacked along the gutters, while material for the cushion could be spread directly on the base.

The bridges were simple enough—only three or four small culverts, which adapted themselves to the use of our standard culverts which are supplied by the Bureau of Bridges of our Springfield department.

With the sections adopted, a grade line was placed which had a maximum of 7%. By means of a planimeter and average end area methods, the earthwork quantities were computed. Effort was made to balance cut and fill, allowing approximately 25% excess in volume of cut to allow for shrinkage and loss in hauling. The quantities once determined, an estimate of cost was prepared, showing item by item, the quantities and estimated cost of the individual items of the proposed improvement.

The Contract

On passage of the final resolution by the County Board, which really was approval of the plans, our department called for bids in July and on August 16, 1916, entered into a contract with the Public Service Construction Co., of Omaha, Nebr. It is to be kept in mind that the State Aid Law in Illinois is such that a contract cannot be let for a figure over the engineer's estimate. A comparison of engineer's estimate with contractor's bid may be of interest first, as it furnishes a check on our method of preparing an estimate, second, these detailed figures though no longer applicable, due to vast increase and war prices, should teach us as engineers to exercise greater caution in using cost data for estimating. Although these figures, estimated cost and bid, are less than three years old, at this writing they probably are 40% or even more, below present prices for the same character of construction.

Comparison of Engineer's Estimate With Contractor's Bid

The following is a comparison of estimate to bid:

General Information.

Monolithic Brick Road	4,100 ft.
Semi-Monolithic Brick Road (Sand-Cement Bed)	800 ft.
Total length to be improved	4,900 ft.
Width of improvement	15 ft.

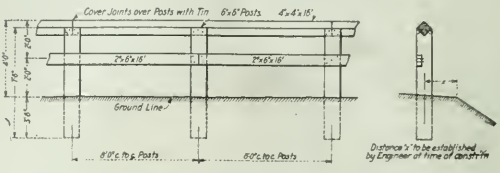
Detailed Information.

Item	Quantity	Engineer's Estimate	Contractor's Bid
Excavation in earth	9,710 cu. yds.	$3,399.00	$ 4,078.20
Borrow in earth	151	53.00	63.42
Overhaul on Earth (775 ft.)	7,809	605.00	780.90
Reinforced Concrete	26.2 cu. yds.	286.00	314.40
Earth Shoulders	5,011 sq. yds.	150.00	350.77
Monolithic Brick Pavement	6,831		12,300.80
Semi-Monolithic Brick Pavement	1,333	15,822.10	2,399.40
Rip-Rap	500 lin. ft.	325.00	300.00
Concrete Gutters	1,600	754.00	1,040.00
Section Markers	2	10.00	20.00
Profit and overhead		2,492.00	
Total estimated cost of work including labor and all materials, is		$23,896.10	
Estimated cement to be furnished by State		2,237.30	
Estimated cost exclusive of cement			$21,658.20
Contract Price			$21,617.80

(Engineer's estimate and contractor's bid are not directly comparable as cement is included in the engineer's estimate while profit is added in a lump sum. The contractor's bid for each item includes profit.)

Relocation

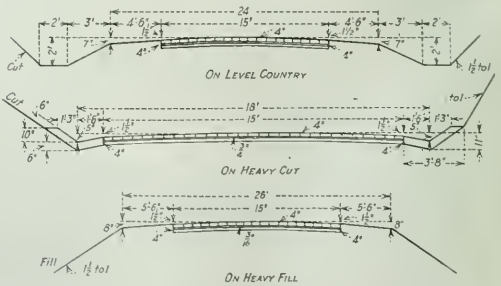
Before improvement began, township and county officials were instrumental in having arrangements made for donation



DETAIL OF STANDARD GUARD FENCE, ILLINOIS STATE HIGHWAY DEPARTMENT.

of additional right-of-way near the foot of the hill, which gave opportunity for improving the alignment. This materially reduced the angle of turn, entirely eliminating a reverse curve and added greatly to the safety of the road. In addition, the character of ground on the new line reduced the quantity of fill which was to the benefit of the contractor and, no doubt, influenced him in favor of the revised plan.

The original improvement was made possible from funds of the 1915 allotment to LaSalle county. Other work previously advanced used up the sum so that only sufficient money for improving the 4,900 ft. was available. Our contract made it possible to enter into extension work not to exceed 40% of the total cost of the original contract. As construction did not begin until September, and the 1916 allotment became available after acceptance by the county board at its September meeting, an extension from station 49 to 66 was provided at the same unit prices as submitted by the contractor in his original proposal. Consequently grading and placing of pavement began at station 66 and advanced toward the village.



THE LEVEL COUNTRY, HEAVY CUT AND HEAVY FILL SECTIONS OF THE BRICK HIGHWAY SOUTH OF SENECA, ILL.

Grading—Use of Steel Shod Wood Drag

The earth grading was placed in layers and compacted by the 10-ton roller to the height of subgrade for the pavement. This height was given by stakes of our engineer, every hundred feet, placed well out beyond the berm line of the graded road. As the excavation approached the desired elevation, it was again checked and a short stake driven to elevation of subgrade on

the center line. The resulting surface, even after the stake was reached, was rough and somewhat irregular; so much so that it would have required considerable hand work to prepare the subgrade if the usual method had been employed. In preparing this finished earth grade the contractor employed a wooden drag, cut to crown of the earth surface, shod with steel with a length about 1 ft. greater than the width of the pavement. This, operated by teams, after two or three trips, gave excellent results. The earth shoulder outside of the pavement was not graded up until the hard surface had been placed and cured.

Concrete Base

The concrete base, mix 1-3½-6, was built from local gravel of average quality, possibly somewhat high in sand, from which all aggregate over 2 in. in size had been screened. It was mixed in a batch mixer using only sufficient water to make a plastic mass. A limit on the amount of water and great uniformity of consistency must be maintained, if a desirable surface of monolithic brick is to result. This base was struck off by the standard template resting on steel forms driven true to grade and alignment. The space between front and back striking edge of the template was kept full of 1 to 3 dry sand and cement which was spread to a depth of 3/16 in. by the proper adjustment of the striker. On this the brick were immediately placed, rolled and grouted. All rolling was done by a small hand roller similar to that used on lawns. This surface was then grouted with a thin mortar and squeegeed until all cracks were filled. No excess of mortar was permitted on the bricks; also any settlement in the cracks or joints necessitated another operation with the squeegee. This finished surface was covered and kept moist, if the weather was warm, for ten days. No traffic was permitted for three weeks.

Gutter Section on Hill

The gutter section on the hill was built monolithically in regard to base and gutter. When these had cured sufficiently, the brick and sand was hauled in. On the base was placed a ¾ in. dry sand-cement bed, 1 to 4 mix, i. e. one part of cement and four of sand, struck off properly with a template. The brick was then placed, rolled by hand, swept, thoroughly wet and all joints grouted as carefully as in the monolithic work.

In the vicinity of the river the fill is from 15 to 20 ft. high and even though it was widened to 26 ft., local people desired protection. Additional work contract was arranged and our standard guard fence constructed on each side as far back as the cross road near station 5. Later, an additional 100 ft. was placed on the outside of the turn near station 7, to provide warning at the change of direction. The details of the standard guard fence are here shown. On this standard guard fence it is specified that the lower 3 ft. 6 ins. of posts be dipped in creosote. The fence is painted with two coats of white lead paint. The posts are of cedar or oak; all other lumber of yellow pine. If round posts are used they are at least 6 ins. in diameter at the small end.

At this writing the road has been under traffic for more than two years, without maintenance, and is in excellent condition.

Design and Construction of the Dixie Highway from Rockwood to Monroe, Mich.

By Leroy C. Smith, Engineer-Manager, Wayne County, Detroit, Mich.

When the United States entered the world war and turned its industries to producing war materials on an extensive basis, one of the first problems to be dealt with was the inability of the railroads to handle the transportation of these materials.

Sending Trucks Overland

This condition showed the absolute necessity of good highways over which war materials could be transported in the least possible time and at a nominal cost, time being the first consideration. Detroit began sending trucks overland about Dec. 15, 1917, and up to Oct. 1918, had sent approximately 18,000 trucks to the seaboard. This figure does not include the cars sent by the Dodge and Ford plants, which probably greatly exceed this number. Exact figures are not available.

Temporary Macadam Road

There remained between Rockwood and Monroe a part of the Dixie Highway, eleven miles in length, which had not been completed. The State Highway Department and the Monroe County Road Commissioners built a detour for this part of the road as an emergency measure. This was built of macadam on frozen ground and answered the purpose very well the balance of the winter. However, when the frost went out in the spring, this road became almost impassable and remained so until it was scarified and reshaped last August.

With this condition confronting the State Highway Department no item was overlooked so far as possible to assure the completion of the main road during the season of 1918.

Permanent Concrete Road

The labor contracts for the Dixie were let in April and May, 1918, the north 6.2 miles to the R. D. Baker Co., and the south 4.8 miles to Lennane Bros., the State furnishing all materials and the work was started at once.

Quantities Involved

The metal top is 18 ft. wide with a uniform thickness of 7 in. and 5 ft. shoulders, making a 28 ft. roadway. The grade is uniform, with no heavy cuts or fills, the country being low and level and the soil a heavy clay the entire length. The season was an ideal one for laying concrete over this type of subgrade. On the north 6.2 miles the mixer was started on June 8, and finished September 1, with only 1½ days lost on account of rain and 4 days out for moving the machine, laying a total of 67,047 sq. yds. On the south end where more grading had to be done, the laying of the concrete was finished on September 18, a total of 48,150 sq. yds., making in all 115,197 sq. yds., of pavement laid in three months. The culverts and two small bridges required about 340 cu. yds. of concrete. The total earth excavation amounted to over 43,000 cu. yds. and was evenly distributed over the entire road.

Handling Materials

Pebbles and sand were furnished by the Ward Sand & Gravel Company of Oxford and the Tecumseh Gravel Company, and although the railroad facilities are very good, the handling of the material was the real problem of the entire job. For the south end we made use of an abandoned stone quarry about 1½ miles north of Monroe on the New York Central Railroad. This furnished storage for cement, repair shop for equipment, etc. The material was unloaded from the cars with a railroad clamshell, usually direct into the industrial cars which carried it to the job, although a bin was constructed from which the cars could be loaded. A clamshell of this type can shunt its own cars and has a distinct advantage over the other type in this respect. A 1¼ yd. bucket will handle on an average of 10 carloads per day, and with an unloading capacity thus limited and the required amount of material so nearly equal to it, the bunching of cars at the point of shipment or in transit was bound to work a hardship. These conditions had to be reported at the main office, according to the Government ruling and when 20 cars or more were held 48 hours for replacement, on account of the inability of the consignee to receive them, an embargo followed. This occurred twice during the season and as 1,156 carloads of material were unloaded in the space of three months and neither job held up on account of material, we felt that the work was handled successfully.

The yard for the north end was located at Newport on the Grand Trunk Railroad, and the same method was used for unloading and conveying the material to the road.

On each job only one industrial locomotive was used. On the north end it was necessary to operate 24 hours much of the time in order to keep a safe distance ahead of a Koehring 3-sax mixer. The aggregate was mixed 1:1-½:3, with a minimum time of 45 seconds for mixing. It was sometimes necessary to increase the amount of sand to obtain the proper mix.

Joints

A ⅜-in. Carey Elastite joint was used and spaced 33 ft No steel protection plates were used. The joints were brought as nearly flush with the surface of the pavement as possible and the belt finishing done over the joint. Care should be taken where this method is used and if the joint should settle more than ⅛ in. below the surface of the concrete, the finisher with a pair of pliers can raise them to the proper place. A sectional joint simplifies this operation and is more satisfactory in every way than the rolled joint.

Belt Finishing

The finishing was done first with an 8-in. belt and followed up with a 12-in. belt. The distance and time between the two operations is dependent upon the consistency of the mix and the weather. This method of finishing gives an excellent riding surface, the joints being entirely unnoticeable.

curve is approached from both directions by from 0.6 per cent. to 0.9 per cent. down grade, while the other is on a practically flat grade. Either curve can be taken with safety at 30 miles per hour, and as no claim for damages has been made, it is evident that the state speed law was not being observed.

Curing and Drainage

The pavement was cured by covering with earth and keeping the earth wet for four or five days. The drainage on this road also presented difficulties, the highest elevation being 20.1 ft. above Lake Erie mean level and the road at the nearest point, approximately one mile from the lake. At one place it was necessary to lay 1,200 ft. of 12-in. drain pipe, making a maximum cut of 7 ft., in order to get the water to an outlet. There still remain two places where outlets will have to be provided to carry the water from the highway. Steps have been taken to have this done as soon as possible.

Nearly 1,400 ft. of guard rail has been built at the corners and curves.

Where Stoney creek crosses the road, at a point 4.8 miles north of the south end, a 3-span reinforced girder bridge was built. This was let to another contractor, the material being furnished by the State. This bridge was completed Oct. 3, so

VIEWS OF NEW CONCRETE PAVEMENT ON DIXIE HIGHWAY BETWEEN ROCKWOOD AND MONROE, MICH.

There are twelve curves which were widened and superelevated. These curves varied from 9 to 67 degrees, the two sharpest ones being 50 degrees, 40 minutes and 67 degrees 13 minutes respectively. The method used is one devised by the State Highway Department, a brief description of which follows:

Method of Widening and Superelevating Curves

Taking the P. C. of the curve, station back three stations of 25 ft. and one ahead, making a distance of 100 ft., in which the superelevation is carried out, beginning at the first station with a normal section, the outer grade line is raised to the maximum amount of superelevation, at the fifth station, or 25 ft. past the P. C. of the curve. This grade is carried to within 25 ft. of the P. T. of the curve, where the same method is used to revert to the normal grade. The amount of superelevation is governed by the radius of the curve. For radii of 66 to 101 ft. ¾ in. per foot of width, or 18 ins. The extra width of 4 ft. was added to the inside and begins 75 ft. back of the P. C., or the same point at which the superelevation started. The inner grade line should always be uniform. In case of a reverse curve or where only a short distance separates the P. T. of one curve and the P. C. of another, the extra width of metal should be continued through both curves. The inner grade line should take the form of a simple curve and meet the regular grade line about 75 or 100 ft. back of the P. C. It is apparent that only station 5 falls inside the curve and should be located as a chord of the curve, and as 10-ft. chords are used in laying out the curve, it is necessary not to confuse the two in putting on the superelevation.

Danger signs and guard rail, and at one a red light has been placed, yet several fatal accidents have occurred there. It is the writer's opinion that this is due to the fact that this

that the entire road was ready for traffic Oct. 15, 1918, and was officially opened on that date.

Cost

The cost of the entire job, including the bridge, will total more than $320,000, which is distributed as follows:

Proceedings	$ 49.72
Inspection	3,696.13
Freight	49,952.82
15,965 tons, 27,890 tons, 35,435 bbls. sand, gravel and cement	96,532.80
Unloading, placing material and laying concrete, grading and buliding shoulders contracts	171,388.64
	$321,620.11
Building shoulders on work done, 1917	2,500.00
	$319,120.11
Material furnished Stoney Creek bridge	5,736.10
	$313,384.01

Length of road—10.70 miles.
Cost per mile—$29,268.70.
Cost per sq. yd.—$2.72.

Highways and Railways for the Defense of Our Nation

A national defense plan requiring extensive construction and improvement of highways and railways along the borders and coasts of this country is outlined in an illustrated booklet recently issued by Sauerman Bros., Monadnock Block, Chicago. The booklet consists of an extract from a paper written

in October, 1916, by Capt. H. B. Sauerman. This plan of defense has been highly approved by engineers and army officers. It has been indorsed by some of our greatest military leaders. It is noteworthy that this paper was prepared many months before this subject was at all popular and before its importance was appreciated even by the initiated. The author suggests a defense area from 14 to 20 miles wide extending along the entire coast line and the southern border, with mobilization points from 20 to 100 miles apart.

The requisite railway and highway facilities suggested by Captain Sauerman comprise:

A double-track, private or government owned and operated, railroad connects all mobilization points. A number of the best located mobilization points are made into permanent camps for training, maneuver and target practice. The other mobilization points are simply laid out and mapped and in case of war are then put in shape for mobilization. At each mobilization point sidetracks are provided for the unloading of men and supplies. This railroad also connects with the interior railroads and highways which bring men, supplies, ammunition, etc., from the interior of the country to the different points along the coastal railroad.

From the coastal railroad, at approximately right angles toward the coast or border, single spur tracks are built at regular intervals and at the most strategic points. These spur tracks are used in time of war by the heavy rail mounted guns of 12-in. caliber and larger and for the transportation of the ammunition.

Improved highways 20 ft. wide are also built at approximately right angles to the coastal railroad. These improved highways are built from 1½ to 3 miles apart and they lead directly to the coast lines. Other improved highways are built parallel to the railroad; these highways are located from 5 to 8 miles apart. Highways in all the interior states must be improved in order that the supplies, men, etc., can be rapidly transported to the defense area in the shortest possible time.

In times of peace both the railroads and the highways will form a great commercial asset to our country and will facilitate shipping.

Copies of this interesting booklet may be obtained from Sauerman Bros. for the asking. It is attractively illustrated, showing the importance of good roads in modern and adequate national defense.

The High Service Reservoir of the St. Paul, Minn., Water Works

By W. N. Jones, Mem. Am. Soc. C. E., Mem. Am. W. W. Assn., Designing and Constructing Engineer.

Historical

For several years previous to the year 1910, it was evident that the city of St. Paul was sorely in need of extensive improvements to its water supply, but as is generally the case in municipally owned works, nothing at all was done in the matter, until necessity forced the city authorities to take some action to relieve the situation.

During the summer of 1910 an exteremly hot, dry spell prevailed over the entire Northwest and made it absolutely necessary immediately to improve and increase the water supply of the city of St. Paul. Accordingly, the late L. W. Rundlett was called in and upon his advice artesian wells were drilled at various points and fully equipped with all the necessary piping and machinery. This relieved the water shortage very materially and supplied water of very good quality, but it was extremely hard and unfit for continued industrial uses. At best these wells could only be considered as an emergency measure, as upon thorough investigation it was found that they would prove inadequate for long continued use on account of their limited water supply area. Notwithstanding these conditions nothing further was done in the matter until the spring of 1912 when G. O. House was appointed general superintendent of the water department.

Mr. House immediately reorganized the entire water department and began the study of needed improvements. Among the works contemplated by Mr. House was the construction of two additional reservoirs for storage and sedimentation, but not caring to make final decision upon such an important matter, and being very busy at the time with the distribution system in and about the city itself, Mr. House advised the Board of Water Commissioners to employ an expert in these matters and recommended Mr. Allen Hazen of New York City as the one who, in his opinion, was the best fitted to investigate and make a report upon what was necessary to be done. Accordingly the Board of Water Commissioners retained Mr. Hazen to do this work and to make such recommendations as he deemed proper to fulfill the conditions of supplying the city of St. Paul with a pure and adequate supply of water.

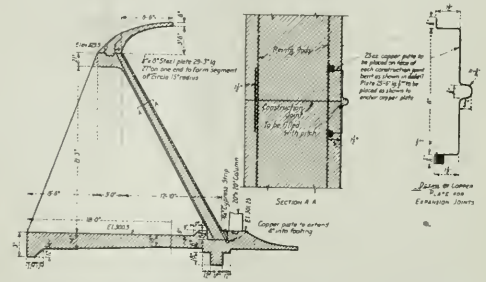


FIG. 1. SECTION OF NORTH, SOUTH AND WEST WALLS OF NEW HIGH SERVICE RESERVOIR OF THE ST. PAUL, MINN., WATER WORKS, SHOWING THE EXPANSION JOINT.

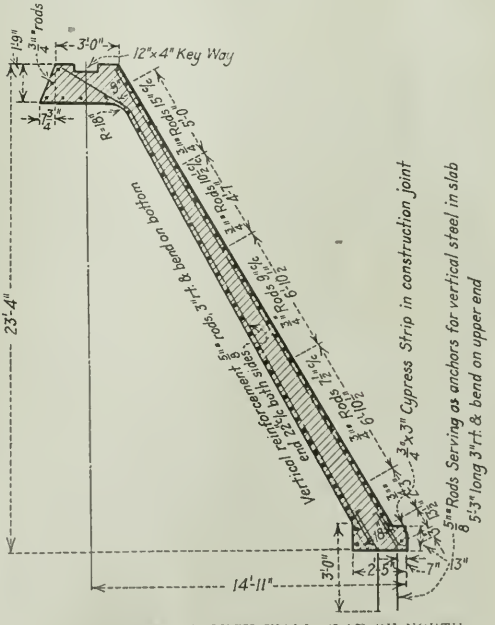


FIG. 2. SECTION THROUGH WALL SLAB OF NORTH, SOUTH AND WEST WALLS.

Recommendations Made by Allen Hazen.

The present supply, which consists of a chain of lakes, and the artesian wells, above referred to, was investigated very fully by Mr. Hazen, as was also the proposition of securing the entire city supply from artesian wells and of using the Mississippi river as a source of supply. The investigation covered fully in all details each proposition and resulted in the following recommendations:

1. That it was not feasible to take from a point near the city a permanent supply from artesian wells and that the cost of doing so and softening would be too great.

2. That the wells as already drilled and equipped should be used but seldom and should only act as an emergency reserve for use in very dry years or to help with extreme peak loads.

3. That the present system of supply from the chain of lakes should be continued, but that increased storage should

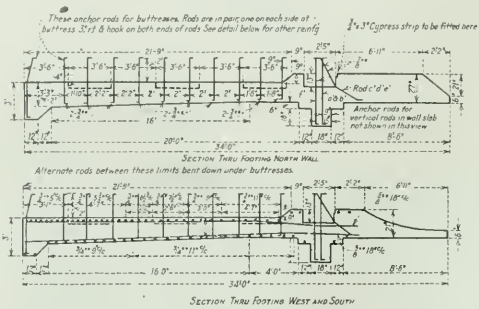

These anchor rods for buttresses. Rods are in pairs one on each side of buttress 3'-1" & hook on both ends of rods See detail below for other reinfg
¾"x3" Cypress strip to be fitted here
Rod c'd'e'
Anchor rods for vertical rods in wall slab not shown in this view
Section Thru Footing North Wall
Alternate rods between these limits bent down under buttresses
Section Thru Footing West and South

FIG. 3. SECTIONS THROUGH FOOTINGS OF NORTH, SOUTH AND WEST WALLS OF NEW ST. PAUL HIGH SERVICE RESERVOIR.

be provided for by building a dam across Rice creek at its outlet from Lake Baldwin, and that this storage should be augmented when necessary by pumping from the Mississippi river.

4. That the capacity of the conduit between the lakes be increased.

5. That additional pumpage capacity be installed at the main pumping station. (This has now been done.)

6. That a mechanical filter plant with all necessary appurtenances be constructed as soon as possible.

7. That a covered high service reservoir of 60,000,000 gals. capacity be built, the reservoir to be in two equal sections or parts, only one of which need be constructed immediately, the other section to be built at some future date when the consumption reached such proportions as to demand additional storage, the old reservoir to be kept in condition as a reserve, and

8. That additional mains and connections be laid as required.

Author Chosen as Designing and Constructing Engineer.

Mr. Hazen was very careful to impress upon the Board of Water Commissioners that his recommendations be followed in detail. Mr. House was, therefore, empowered to engage an engineer to design and carry on the work. He chose the writer as his designing and constructing engineer and gave him full authority to proceed with the design and construction, subject to the approval of the Board of Water Commissioners, of such parts of the entire work as was deemed most urgent and for which the water department had funds available.

Starting the Work

Much study and consideration was given to the subject and it was finally agreed that as the old reservoir was small and ill-suited for its use, a new reservoir was primarily very badly needed. Accordingly an office force was organized and early in the spring of 1916 the design of the high service reservoir was started. Keeping Mr. Hazen's recommendations and general plans for the entire work well in mind, the design was pushed as rapidly as possible and bids were asked for early in June of 1916.

At this time prices of material were showing a decided raise and although several very fair bids were received, the Board of Water Commissioners deemed it, in spite of the engineer's recommendations, wise "to take a chance" on lower prices, therefore, all bids were thrown out as too high.

Soon after this the Board, upon recommendation of Mr. House and the writer, contracted directly for all necessary piping, valves, special castings, cement and reinforcing steel and re-advertised for the construction of the structure.

The Geo. J. Grant Construction Co. of St. Paul, being the low bidder on this second bidding, was awarded the contract sometime in August, 1916, and began work on the structure early in September of the same year but to date have not fully completed their contract.

On account of local conditions and the location of the existing distribution mains, pumping station, etc., only one site was deemed available for the new reservoir. This site was of limited extent, very near and just north of the old reservoir on the top of a hill about 300 ft. above the city datum and sloping downward in all directions. As the city owned most of the top of the hill, an attempt was made to locate all the structure on city land, but this could not be done on account of the size of the proposed work and the desire to care for future extensions. After considerable study, it was decided to build a reservoir about 425x452 ft. in plan. The capacity of the new reservoir is 30,712,000 gals. with a depth of water of about 24

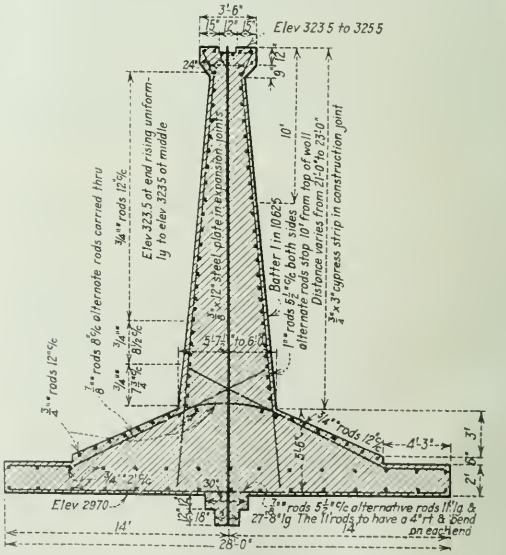

Elev 3235 to 3255
Elev 3235 of end rising uniformly to elev 3235 of middle
Batter 1 in 10.625
Distance varies from 21'-0" to 23'-0"
Elev 2970
14'
28'-0"

FIG. 4. SECTION THROUGH EAST OR DIVIDING WALL.

ft. This necessitated the acquiring of approximately 7½ acres of additional land, but the parties owning this land refused to sell under $1,000 per acre, although land in the immediate vicinity, with improvements, was selling for $150 per acre. Condemnation proceedings were at once started and pushed vigorously through the court resulting in the award of $250 per acre for the condemned property.

Design

The customary assumptions relative to water pressures and the action of concrete and steel in combination to resist all external stresses were followed in the design. Concrete of a

1:2:4 mix was specified. All concrete was assumed to stand safely a unit stress of 650 lbs. per square inch in compression and nothing was allowed in tension. All steel was assumed to carry safely 16,000 lbs. in tension,, excepting in the large dividing or east wall, where 20,000 lbs. per square inch was allowed.

In designing the walls the concrete and steel was proportioned so as to withstand any and all stresses which they might be subjected to under any and all maximum working conditions with the reservoir full and empty, no reliance whatsoever being placed upon the earthen embankments. In other words, were the embankments removed entirely from around the structure, the concrete walls would still remain in place and perform their work satisfactorily, a condition which will actually occur when the additional capacity is being provided. Sufficient steel was placed in the inside faces of all walls to

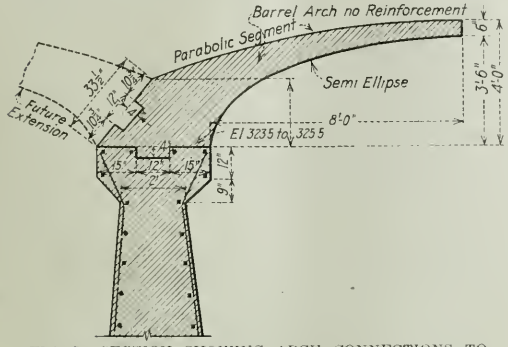


FIG. 5. SECTION SHOWING ARCH CONNECTIONS TO EAST, OR DIVIDING WALL.

withstand a hydrostatic pressure on the outside equal to that caused by a head of water equal to the depth of the point in question below the maximum flow line of the water in the reservoir. It was assumed that some leakage from the reservoir through the concrete walls would take place and that the clay embankments would naturally prevent the water from flowing away, thus reversing the stresses whenever the reservoir was rapidly lowered on account of the excessive use of water or when drained for cleaning or repairs.

The Walls

Many types of walls, especially those of the gravity and buttress and counterfort types, were investigated, both from an economic standpoint and as to stability, resulting finally in the type adopted. As will be noticed from the accompanying cuts this type depends partially upon the water for stability while the thrust of the arches is carried into the buttresses by means of a heavy reinforced concrete beam and thence into the footings where a heavy reinforced concrete slab distributes the load over the ground in such a manner as to prevent any overloading of the foundation. In order to prevent any sliding of the walls or footings on the clay below, heavy reinforced concrete beams were provided underneath the foundation slab, while the walls and buttresses were notched frequently to prevent any sliding of concrete on concrete; thus it would be necessary for the concrete to fail in shear before any movement or failure could occur at the various horizontal points.

The east wall, or the dividing wall between the new reservoir and the future extension, was designed as a cantilever gravity wall and, like the outside walls, depends partly for its stability upon the weight of water directly upon it. Provisions against sliding were also made by means of a beam dropped well into the clay below and the top was enlarged and well reinforced to care for any and all the arch thrust that could occur when the earthen embankments were removed. Provision was also made by grooving the top, to make a good and sufficient seat and bearing for the first row of arches in the future extension.

Clay Placed Under Floor

In order to prevent seepage through the subsoil, which test pits showed to be composed of sand and gravel, the design called for the excavation to be below grade and to be brought back to grade by a backfill of clayey material well sprinkled and rolled in 6 in. layers with a 15-ton roller, having at least 300 lbs. per lineal inch of tread on the main wheels. At first a layer of lean concrete about 6 ins. thick instead of the clay was considered, but upon investigation it was found that the clay blanket was much cheaper and would answer the purpose just as well. As a further precaution against leakage, wood strips, like those at Baltimore, Md., were designed to be placed between all construction joints in the footings, while all joints in the sloping walls were closed by a special copper and asphalt expansion joint.

Arches and Top Covering.

On account of the ease of construction, low cost, freedom from air pockets and rapidity of construction, inverted groined arches were designed for the column footings while groined arches with depressions in the top were designed for the vaulting covering the structure, these in turn being covered to a depth of 21 ins. above the crown with a clayey material with 3 ins. of black loamy soil suitable for the growth of grass and shrubbery on top of the whole. Past experiences in this vicinity have demonstrated that while 24 ins. of earth over the top of a reservoir does not fully protect the water in reservoirs of this type from freezing slightly, it is nevertheless adequate to prevent any damage from the action of the ice if the outside walls are also well protected. (The greatest thickness of ice has never been over ¾ in.) The embankments, therefore, were not only designed to prevent leakage, but also to protect the structure from the extreme and sudden changes in temperature which occur in these latitudes, to act as a roadway around the top of the reservoir, to provide sufficient room for erecting machinery during repairs and additions and to form a foundation upon which to plant grass, etc., thereby adding to the attractiveness of the whole.

In order to provide for uniform flow across the reservoir from the inlet conduit to the outlet conduit and to prevent dead

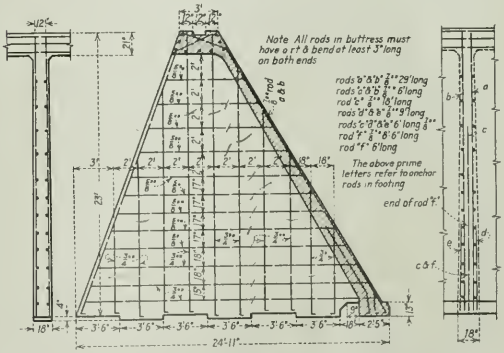

Note All rods in buttress must have a rt & bend of least 3" long an both ends
The above prime letters refer to anchor rods in footing
end of rod 'f'
24'-11"

FIG. 6. ELEVATION SHOWING BUTTRESS REINFORCEMENT.

spaces, pinched outlets were provided. Whether these will act as contemplated is not known but as they are easily changed at no great expense it seemed worthy of a trial.

The gate chambers, which are situated, one at each end of the dividing wall, and forming a part thereof, were designed to care for an additional reservoir equal to the one being constructed and sufficient gates were placed therein to meet every demand of flexibility of operation under any and all conditions.

Aerator

To eliminate the fishy and weedy smell, which the lake

water contains at certain times of the year, more especially near the end of the summer or early fall, an aerator was incorporated in the design. The design of this aerator was based largely upon one installed and tried out by the water department four years ago with very satisfactory results. By decreasing the size of and increasing the number of holes in the plates, increasing the area of the plates and the distance between them, and by using one more plate it is thought that even better results will be obtained. In order to prevent frogs, snakes, rats, gophers, etc., from getting into the water, the aerator is to be screened in on the lower part. As the aerator is to be used for only short periods during each year, a by-pass has been provided to carry the water to it during its use, at other times the water will pass directly into the gate chambers and the aerator will be closed off and boarded up. This will make a material saving in cost of the water pumped as the cost is based solely upon the quantity and the head pumped against.

Limitation on Steel and Concrete Mix

All steel incorporated in the structure must be deformed and not square twisted, the square twisted rods being thrown out on account of the results obtained in a series of tests carried on at the University of Illinois Engineering Experiment Station, under the direction of Prof. A. N. Talbot, a description of which may be found in Engineering and Contracting of June 24th, 1914. Plain rods were not considered, although cheaper, on account of the manner in which the work might be done. It was desired that some mechanical bond be provided and the deformed bar seemed the only way of securing this result.

The design calls for no waterproofing whatsoever, as past experience has proven that a 1:2:4 concrete when properly mixed and placed will give satisfactory results under conditions similar to those which will occur in the reservoir. The spouting of the concrete into place was also prohibited as spouted concrete, especially if it has an excess of water will show air pockets. The specifications call for a reasonably water tight job such as should be expected of first class work and the contractor must guarantee the work. Should any excessive leakage take place, the contractor is required to go over the entire surface exposed to the water with a cement gun placing sufficient mortar thereon to fulfill the conditions of the specifications. (Note: The reservoir is now under test and proves satisfactory relative to leakage, etc.)

Data Furnished All Bidders

Complete data and specifications were furnished all bidders and such part of the specifications, as were deemed necessary, were especially called to their attention. For instance, the time of mixing of the concrete, 1 and ½ minutes in the drum was noted and all bidders informed that this must be done. The spouting of the concrete from the mixing plant into the forms was also prohibited and the fact called to each bidder's attention.

Test pits were dug wherever desired and samples of the different materials encountered at different depths bottled and placed on exhibition.

Information as to railroad sidings, available sites for borrow pits and spoil bank were located, analysis of different materials were made and recorded and kept open for the bidder's information.

All quantities in the structure were carefully figured, checked and tabulated and each bidder furnished a copy with a blank space for his estimate. This was done in order that each bidder would figure on the same item and quantity and as the specifications calls for unit prices on each item, every bidder was, as the saying goes, "in the same boat," thus no bidder was placed under unnecessary expense in taking off quantities and each knew exactly what he was figuring on.

Personnel

Mr. G. O. House was general superintendent of the water department at the time of the design. The writer was designing and constructing engineer in full charge of all work and was ably assisted by Mr. J. W. Kelsey, recently appointed superintendent of the St. Paul water works department, but who is now serving with the American Expeditionary Forces as captain of engineers in Germany.

Sanitary Carts and Wagons

A line of sanitary carts and wagons that is much praised by users is manufactured by Geo. H. Holzbog & Bro., Jeffersonville, Ind. These carts and wagons have closed metal bodies so they are smell-tight and cannot leak. Cities that have changed over from the practice of hauling garbage in open and leaky wagons to the use of these tightly covered sanitary vehicles are much pleased with the results now secured. The 4-wheel catch-basin wagon is also popular wherever employed. Its advantages are obvious to all familiar with the haulage incident to catch-basin cleaning. These vehicles are easily washed out, and, being of all-metal construction, do not require frequent repairs. The dump carts have circular bottoms, thus reducing corners and angles to a minimum, and this facilitates cleaning. The freedom from odor is especially appreciated by officials, as this forestalls criticisms from citizens along the collecting and hauling routes. Among those reporting to the editor their satisfaction in the use of this line of vehicles are the borough engineer of Princeton, N. J., and the secretary of the borough of Tarentum, Pa. These vehicles are supplied with either two or four wheels, for one or two horses.

Opportunities for and Data on Small Municipal Hydro-Electric Plants

By Wm. G. Fargo, of Fargo Enginering Co., Jackson, Mich.

Throughout the United States, but particularly in those parts not highly populated, but which are now being developed, there are communities quite beyond the reach of existing public or private utilities and which desire the advantages of electric service. Unless the construction of an electric power station and distribution system is undertaken by the municipality it is quite uncertain when electric service will become available to the community. No argument is now needed to convince the average American citizen of the worth

FIG. 1: OLD MILL WATER POWER PLANT REDEVELOPED FOR AN ELECTRIC STATION.

to him of electric lighting and power service for home, business and farm purposes. Here, then, is the opportunity for a progressive community to install electric equipment, supply itself and the nearby country with electric current and thus make available the essentials of modern comfort, and generally to "put itself on the map."

The Field For Municipal Ownership

The time may come, years afterward perhaps, when the little plant built by the village is in part at least approaching obsolescence, or the end of its useful life, that it may be taken over by some well organized public utility corporation with profit to the village or city, but if electric service is to be had in the meantime the surest way to start it off is for the village to promote interest and build a plant.

Where oil fuel is cheap an engine driven plant is often the most practical for small towns. In larger communities, say of 5,000 or 10,000 population and upward, with no available water power and free burning coal at fair prices, a steam plant is likely to be the most economical source of power. But where a water power site exists within a few miles of the village or city, it should be carefully considered.

Reclaiming Abandoned Water Powers

Throughout the older portions of this country there are numerous abandoned water powers formerly used for grist and saw mills and in the eastern states for small factories. Often the dams and headworks, if nothing more, still remain in fair condition and can be secured together with the rights and privileges, for reasonable sums. Taking the case of a disused mill, it is frequently possible to utilize the old water

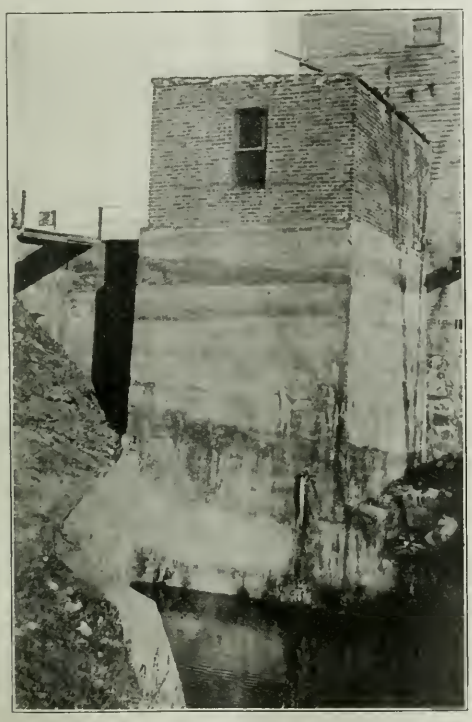


FIG. 2: CLOSE VIEW OF PENSTOCK OUTSIDE MILL SHOWN IN FIG. 1.

wheels to drive by belt an electric generator located in the mill. If the water wheels are very old, say dating back of 1875, and all of the power of the stream is needed to supply the town, then it will be best to install new equipment.

Minimum Head

It will be well to consider placing the new turbine in concrete setting outside the mill with a small fireproof house over it to contain the generator and switchboard, if a vertical direct connected generator is used, which constitutes the best and most efficient equipment. If the cheaper horizontal belted generator is to be used the turbine can frequently be located to advantage outside the mill, driving the generator by belt. A horizontal generator placed in the mill can be driven from a vertical shaft water wheel (outside the mill if desired) by means of a quarter turn belt. The pulley on the vertical water wheel shaft in such cases is of necessity large, sometimes 12 ft. or more in diameter on account of the low speeds of the larger water wheels under low heads of water. In general no head of less than 12 to 15 ft. should be considered on a small stream.

A Specific Example

In the accompanying half tones are shown an old mill power of 18 ft. head redeveloped for an electric station. Figure 1 shows the spillway in the left foreground and the mill to the right with the small square concrete penstock at the corner of the mill. The objects in locating the penstock outside the mill are first; that it makes unnecessary underpinning the mill walls to get the desired depth for the turbine discharge pits, and second; the lesser fire risk with the generator outside in a small fireproof building. Figure 2 shows a close up view of the penstock, which is about 14 ft. x 16 ft. outside dimensions and contains a 15 in. turbine developing 75 hp. at 18 ft. head, speed 400 r. p. m. The generator is 50 kw. This installation was built without much engineering advice and supervision but is a good practical installation without unnecessary features.

This little plant, with a 40 hp. oil engine auxiliary, serves three villages having a combined population of 1,150. Twelve miles of transmission line on cedar poles connect the three villages. The primary voltage of the generators is 2,300 volts and this is stepped up to 6,600 volts for transmission. Some farm customers are now supplied and more are ready to take current. The total number of services is 171 at present or 150 per thousand population served. The total investment is about $40,000, including lands, rights, equipment, transmission and distribution systems and the various assets of a going concern.

Equipment and Power Per Capita and Costs

In prosperous farming communities in the middle west where the towns are largely made up of country merchants and retired farmers, the number of services per 1,000 population will range from 200 to 250 with 225 as a fair average. In less prosperous or less progressive sections the services per 1,000 population may be as low as 100.

With about 225 services per 1,000 the station generating equipment needed will be 60 to 70 kw. or say 90 hp. per 1,000 population. This includes some auxiliary power. The cost of small low head water power plants with dams, not including transmission lines and distribution systems, at April, 1919, prices will usually range in cost from $200 to $400 per kw. installed, on a 30% to 50% load factor basis. Where a dam and mill in fair repair are available the additional cost of completing the hydro-electric development over and above the cost of the property and exclusive of transmission and distribution lines may be between $100 and $160 per kw. of generating equipment installed, including new penstock, wheel setting and generator room. Small steam plants (100 to 500 kw.) will cost from $150 to $100 per kw. and a complete oil engine plant of moderate size will cost 5 or 10 per cent. less than a steam plant of equal capacity.

Transmission and Distribution Costs

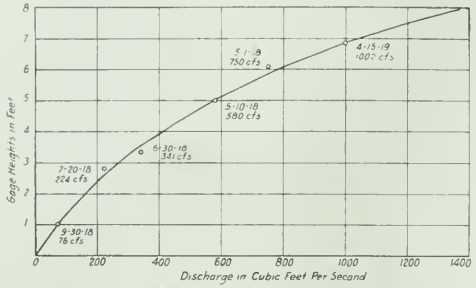
If more than one community is to be served from the same generating plant or if the source of power is some distance away from the market, transmission lines are necessary, operating usually at a secondary voltage or pressure higher than that of the primary voltage at which the current is generated. The voltage is "stepped up" from the primary pressure of perhaps 2,300 or 6,600 volts to 13,200, 22,000 or 33,000 volts by means of transformers. The higher voltages being used on the longer lines or those more heavily loaded to lessen the cost of the copper conductors. Wherever the current is to be used for power or light "step down" transformers are installed and the current is usually distributed at 2,300 volts in the larger towns and again reduced to about 110 volts for residence uses or to 220 volts or 440 volts for factory power.

Transmission lines serving country towns up to 2,000 or 3,000 population will ordinarily cost from $1,000 to $1,500 per

mile when built on the highways using 30 to 35 ft. cedar poles and No. 6 or No. 4 bare copper wire. Farm lines cost from $700 to $1,000 per mile.

The distribution systems in a series of 46 country towns in a middle west state with populations ranging from 100 to 4,000; 36 of the towns being under 1,000 population cost on an average of $51 per service or $11.10 per capita, including distribution transformers and customer's meters. The cost of customer's meters averaged about $9.50 per service. The distribution transformers averaged $9.80 per kv. a. capacity, ranging for the most part from $7.50 to $12 per kv. a. The total population for these 46 towns was 40,300.

The above transmission and distribution figures are for April, 1919 values with common labor at 35 to 40 cts. and copper wire base of about 19 cents. These costs are also essentially equivalent to an average for the years 1913-'14-'15 '16 and 1917 and are for plain substantial construction with suitable lightning protective devices throughout. To esti-



EXAMPLE OF RATING CURVE FOR DETERMINING INTERMEDIATE STREAM FLOW BASED ON SEVERAL FLOW MEASUREMENTS.

mates made up from the above figures should be added contractor's profit and any general overhead expense as for supervision, engineering and financing.

Operating Costs

For the purpose of comparing the relative cost of power produced from the three different types of plants; namely, water power, steam and oil plants, the following tabulations are presented. The figures being derived from actual cases.

(A) Water Power:—200 kw. capacity.

Head 12 ft.; drainage area 140 sq. miles; annual rainfall + or — 30 ins.; usual summer water 70 cu. ft. per second; average yearly flow 140 c. f. s. Plant capacity 250 c. f. s.—200 kw. Cost of rights, dam, plant, equipment and 4 miles of transmission line.....$47,000

This is at the rate of $235 per kw. installed. Owing to the lack of water at certain times it was necessary to consider an auxiliary source of power and a 100 kw. steam plant is estimated at $12,000

Total cost of water power and auxiliary.....$59,000

Fixed Charges: (Interest, taxes and depreciation)			
For Water Power Plant		$4,700	
For Steam Plant		1,440	
			$6,140
Operating Charges:			
For Water Power Plant		$2,300	
For Steam Plant Operators	$450		
Coal @ 6 lbs. per kw. h. and $5.00 per ton	720		
Miscellaneous	300	1,470	3,770
Total annual charges			$9,910

Assuming that this plant can operate at 25% load factor the total annual output will be 360,000 kw. h. and on this basis the cost of power delivered at the end of the transmission line will be 2.76c per kw. h.

(B) Steam Plant: 200 kw. (No other source of power)

Cost of 200 kw. steam plant complete			$26,000
Output 360,000 kw. h. annually (25% load factor)			
Annual fixed charges:		$2,400	
Operating charges:			
2 men @ $75 per mo.:	$1,800		
Coal at 6 lbs. per kw. h. 1080 tons @ $5	5,400		
Miscellaneous	1,000	8,200	
Total annual charges		$10,600	

On the basis of 360,000 kw. h. output the cost per kw. h. would be 2.94c.

(C) Oil Engine Plant: 200 kw.

Engine	$14,000		
200 kw. generator	2,000		
Installation and building	3,000		
Total Cost			$19,000
Total output 360,000 kw. h. (25% load factor)			
Annual Fixed Charges: @ 12%		$2,280	
Operating Charges:			
Oil at 10 kw. h. per gal., 36,000 gal. at 13c	$4,670		
2 operators @ $75 per mo.	1,800		
Miscellaneous, supplies, repairs, etc	400	6,870	
Total annual charges		$9,150	

On the basis of 360,000 kw. h. output the cost per kw. h. would be 2.54c.

Hence the oil engine plant will in this case be the cheapest source of power.

(D) Water Power of Greater Head and Capacity

In the actual case from which these figures are taken it is possible to build on the same stream two miles farther from the power market, a water plant of 30 ft. head (instead of 12 ft.) and 550 kw. capacity at a total cost of $120,000, including the longer transmission line, or at the rate of $214 per kw. and this plant together with a 275 kw. steam auxiliary costing $27,500, will produce yearly 1,000,000 kw. h. at the rate of 2.04c per kw. h.

Therefore if it is feasible to utilize the 1,000,000 kw. h. per year which the larger water plant with its auxiliary will produce, then this is a better proposition than the other alternatives, A, B, or C.

The additional power may be marketable at a substantial profit at some nearby town by building 10 or 15 miles of transmission line and providing step-down transformers at the end of the line at an additional cost of about $25,000 for the 15 mile line, etc. In this case the power should wholesale for at least 3c per kw. h. The factory market will also invite investigation and should yield from 3 to 4 cts. per kw. h. or better, depending upon the cost of coal or oil for fuel.

Hints on Water Power Investigation

Flow of the Stream—The yield or discharge of a stream is dependent primarily upon the amount and uniformity of rainfall throughout the year within its drainage area. Assuming an annual rainfall of 25 to 30 ins. and a porous soil underlaid by more impervious strata as clay, shale, or rock, not much fissured, the runoff or stream flow may for eight or nine months per year closely approach 1 cu. ft. per second (c. f. s.) per square mile of drainage area, with a summer mean of 0.5 or 0.6 c. f. s. per square mile.

With a rainfall of 20 ins. and a porous soil not underlaid by such strata as deliver the rainfall to the stream, the available flow for eight or nine months per year may not exceed 0.2 or 0.25 c. f. s. per square mile of drainage. Thus in the first case for a stream with 1,000 miles of drainage, the average discharge or flow for three-fourths of the year will be about 500 or 600 c. f. s. and in the second case 200 or 250 c. f. s.

The power produced by modern water turbines under average working conditions will range from 80 to 90% of the theoretical value of the water at any given head or fall. On the basis of 80% water wheel efficiency the horsepower of a stream equals the (head in feet) times c. f. s. divided by 11. Thus HP equals Qh divided by 11 and HP X 0.746 equals kw. The efficiency of electrical generators will range from 90 to 93% and of transformers about 97½%.

Owing to the great variation of flow of different streams the only safe procedure is actually to measure the water at high and low times by water current meters or floats. A float measurement may be made within 10 to 20% of the truth in any stretch of the stream with uniform cross section which is straight for a distance of about four times its width. Upon a bridge or wire stretched across the stream at right angles, mark off 10 or 20 ft. sections and time floats in each section over a measured course of 20 to 50 ft. Unless vertical weighted floats reaching nearly to the bottom are used, the surface velocity should be reduced 10% for the average throughout the depth. A gage board marked off in feet and tenths should be set at or near the measuring section and read daily. Keep a record of the gage heights when beginning to take the stream velocity measurements and when the velocity measurements are completed. After obtaining several flow measurements covering the annual range of the stream, a rating curve can be plotted and intermediate discharges determined, also a clue to those gage readings which fall below or above the range of the measured discharges.

From the formula HP equals Qh divided by 11 it is seen that the power of a stream varies directly as the fall or head. However, the per cent. loss from backwater in flood times is greater for a low head than for a higher head. Thus, with 10 ft. head and 4 ft. backwater, assuming that the upper pool is kept at a constant height, the power will be reduced to 60% of normal, while 4 ft. of backwater off of 20 ft. head leaves the power at 80% of normal. Then, too, the water wheels will work at a much reduced efficiency at any such variation in head as 40%. Moreover the speed will be so much reduced in this case as to affect materially the cycles and voltage of the generators. It is therefore important to select such a dam site as has a good head, say 20 to 25 ft. or more, and is reasonably free from backwater.

The sort of foundation soil or rock is most important. Avoid quicksand and silt. Deep clay or gravel beds make suitable foundations. In limerock country, investigate the possibility of loss of water through caverns or fissures.

Electrical Characteristics

In selecting electrical equipment the prevailing frequencies and voltages in the section of the country where the plant is to be located should be duly considered in the light of probable future interconnection. Thus while three phase current will be selected for economical transmission, if 25 cycles (or some other) is the predominating frequency in all nearby systems it will be unwise to determine on 60 cycles. Primary voltages over 6600 V. are not recommended and 2,300 volts is better practice. Likewise the interposition of step-up transformers between the generating equipment and the higher voltage transmission lines is advisable on account of the protection it affords against lightning.

Recommended Procedure in the Painting and Maintenance of Highway Bridges

By Charles D. Snead, Bridge Engineer, Kentucky Department of Public Roads, Frankfort, Ky.

No maintenance of bridges will be as effective as maintenance applied regularly each year and the necessary repairs determined by periodical inspection of the structures. Every structure, concrete, steel, wood or pipe, should be inspected at least once every year and a detailed report made upon its condition. More frequent inspections should be made of structures in a bad state of repair, while small culverts should be inspected after every hard rain. By such a system repairs can be made where and when needed. The cost of repairs will not be allowed to accumulate nor will the structure be allowed to suffer from the lack of repairs.

Classification of Structures According to Conditions

I will explain what I should do with the funds you may have available were I county road engineer in your county, and will try to suggest something helpful which may be done by everyone and which must be done if existing structures are to be preserved in suitable condition for traffic.

First—A complete inspection would be made as heretofore suggested and a complete report made of every existing structure within the county.

Second—The structures would then be subdivided into three classes: (A) Structures needing no repair or maintenance; (B) structures which must be rebuilt immediately; (C) structures which may be repaired or strengthened.

Third—The classes noted under (B) and (C) would again be subdivided, the class noted under (B) under three subheads as follows:—

1. Structures which must be permanently renewed, both the substructures and superstructures.
2. Structures in which the substructure only shall be renewed permanently and a temporary superstructure built thereon.
3. Structures in which the substructures are serviceable and require a permanent superstructure.

The bridges noted under (C) would be subdivided as follows:—

1. Bridges requiring strengthening to trusses and floor systems.
2. Bridges requiring no strengthening but new floors.
3. Bridges requiring only painting.
4. Bridges requiring partial painting and repairs to floor.
5. Bridges requiring complete repainting and new floors.
6. Bridges requiring repairs to the substructure.

Would Show Many Things

What would be the value of such a complex system of dividing and subdividing? There are many things it would show quickly. First, it would give a complete list of structures in your county with a classification which would allow the only correct distribution of the bridge fund. Second, it would show your court what was necessary on every bridge in the county during the coming year. Third, it would quickly afford a basis for estimating the money necessary for this maintenance and construction during the year and would be in such a form that it would appeal to every business man in the county because he would know you had investigated conditions. Fourth, it would emphasize the want of funds for this work. Fifth, it would outline this work for your men in advance for the year in every district and eliminate bringing the forces back and forth as these conditions were discovered or reported.

Having completed the report and an estimate of the cost of the work, it should be published in every newspaper within the county with a statement of the funds available and your policy for expending such funds in each district. Everyone would then see that the money had been allotted where needed. This is the only reason for a common pool of the county's funds in the county treasury, and the only equitable way of spending money raised by taxation.

Strengthening and Repairing Old Bridges

Only class (C) structures will be discussed under maintenance. These are bridges which are to be strengthened, painted, refloored, or upon which work is required on the substructure. This work through necessity must be handled both by force account and by contract, and it is well that we con-

sider the most important features of such work—namely, strengthening old bridges, reflooring and repainting.

The old wooden trusses if too light for modern traffic do not offer much opportunity for strengthening at an economical cost. These trusses should be temporarily repaired and their floor systems brought up to the maximum capacities of the trusses. These bridges should be posted with signs warning the travelling public against overloading. The maximum allowable load should be clearly stated on the sign. It is possible that the floor systems can be increased by increasing the number of the floor beams and stringers, or else by increasing the size of floor beams and stringers. This can be economically done at a time when the floor has been removed for stringer repair or reflooring.

Many of the light steel truss bridges can be strengthened by changing the sizes of floor beams and increasing the number of stringers so that they may be made to carry safely double or perhaps three times the present wagon or truck loading. It may be necessary to make changes in connections and in certain web members to increase the capacity, but it can be done far cheaper than rebuilding in many cases. It is far cheaper to spend a few dollars in strengthening than to allow structures to be daily overloaded and their cost of maintenance to soar. There is a certain bridge I have in mind in which it is impossible to keep the floor nailed down in place, due to the fact that the stringers and floor beams deflect so great under the heavy loads that they pull the nails.

There is a suggestion, too, with regard to strengthening bridges which may be accomplished with little additional expenditure. It is more important to be able to get your loads over a structure than it is to save time getting them over. It is possible in some cases to reduce both the dead load on a structure and to confine the moving load to the center of the bridge and thus carry over with safety greater loads. This can be accomplished by reducing the width of travel way of the bridge. The proper fences and guard rails must be installed to prevent accident or traffic from using the remainder of the structure.

Bridge Floors

The day when bridge floors 2½ ins. to 3 ins. thickness can be economically used for modern traffic has passed. For heavy traffic the maximum span for 4-in. flooring should be about 27 ins. This span can be somewhat increased for loads of 10 tons or less, or 3-in. floor used when the spacing of stringers does not exceed 24 ins. Investigation of your bridge floors will show that few of them remain long enough for decay to destroy, but instead traffic wears them out. In replacing wooden floors, if the span is not strong enough and cannot be economically strengthened to carry a better type of floor, it is to be recommended that a 2-in. by 4-in. wooden floor be used, the lumber being laid on edge and all contact surfaces thoroughly swabbed with hot tar and cambered to shed water. This type of floor has been extensively employed on new structures and is giving complete satisfaction. I have just recently had occasion to inspect such a floor which had been down for a period of nearly 6 years, and it showed no signs of decay or wear, yet it was subjected daily to a large volume of heavy traffic, both horse and motor-drawn. The cost of this type of floor is about 50c per square foot of floor surface. In laying this type of floor on old truss bridges whose stringers in the end panels merely rest on the concrete or masonry, it will be necessary to anchor at least the outside stringers to the masonry or else the floor will lift these stringers. About one barrel of tar is required for every 30 ft. of length, if the bridge has a 16-ft. roadway.

The foregoing matter is from an address before the latest Road School conducted by the University of Kentucky.

Novel Method of Pouring Concrete Sewer in Tunnel

A novel method of concreting was employed in constructing the Glen Road section of the Moore Park drainage scheme at Toronto, Ont. The concrete sewer is laid in tunnel under a covering of 25 ft. or less. The total length is 2,812½ ft. The sewer is 4 ft. in height at the crown and 4 ft. 3 ins. in horizontal diameter at the invert, with the profile of the crown walls embodying arcs of three different radii. The minimum wall thickness is 9 ins. The method of concreting is described as follows in The Contract Record: Owing to the lack of space in the tunnel, it was decided not to pour in the conventional way from the tunnel by erecting forms little by little and placing the concrete simultaneously. The crown section would have caused difficulty and extra labor would have been involved in transporting concrete from the shaft to the heading. The contractors in view of this condition, bored post holes through the roadway directly to the sewer tunnel, each hole being in the center of an 8-ft. section. The forms were erected completely, the open end bulkheaded, and the concrete mixed at the surface of the road and poured through the post holes. With a rather soft mixture this scheme worked admirably and the pressure behind the concrete was sufficient to eliminate all voids. When the pouring was complete the post holes were filled with concrete and resurfaced with asphalt. The crown walls were poured before the invert, this being afterwards concreted and keyed to the sides. The mixture was 1-2-3, with 1 in. crushed stone.

Dissolved Oxygen As An Index of the Pollution of New York Harbor

By Kenneth Allen, Sanitary Engineer, Board of Estimate and Apportionment, New York City

Ever since the appointment of the New York Harbor Pollution Commission in 1903, a systematic attempt has been made to keep track of the pollution of the harbor water. The Metropolitan Sewerage Commission, Dr. Geo. A. Soper, president, recognized the value of dissolved oxygen determinations as a measure of the digestive capacity of the water and, inversely, of its pollution, and tests begun by the Commission in 1909 have been continued by the Board of Estimate and Apportionment of the city, of which Nelson P. Lewis is Chief Engineer, to the present time.

Significant Results

The results of these tests are very significant, said Mr. Allen in addressing the American Public Health Association, and show a surprising and persistent decline in the degree of saturation in all parts of the harbor, especially in the Harlem and Lower East Rivers. As is recognized by sanitary engineers conversant with the situation, this is a matter of considerable importance to the welfare of this great seaport, and especially to those living or owning property in the vicinity of its shores. The purpose of this article is to show to what extent the pollution of the main parts of the harbor has progressed, as made manifest by determinations of dissolved oxygen. In all, 2,342 samples were analyzed by the Metropolitan Sewerage Commission and 1,859 by the Board of Estimate and Appertionment.

Interpretation of Results

In the interpretation of results a distinction must be made between those tests made in cold weather and those made in summer. While there is a progressive decrease in the warm weather saturation the winter figures remain high throughout. Even as late as April this holds good, as will be seen from the following:

In April of this year the percentage saturation found in the Hudson River varied from 70.8% to 73.3%; in the Harlem

River from 69.8% to 79.0%; in the lower East River from 76.0 to 79.3%; in the Upper Bay from 62.0 to 77.0%, and in the Kill van Kull from 65.5 to 68.0%.

The lowest average percentage of saturation is seen to be 62% while others range up to 79%—a condition of the water that in this regard may be called entirely satisfactory.

The general conclusion to be drawn from this is that there is no danger of the development of putrefactive conditions with their attendant odors in any of the main bodies of water in New York Harbor during the cold months of the year. And, as a corollary, it follows that for an indefinite time no steps to prevent such putrefactive conditions during cold weather will be necessary. In fact, the saturation figures are so high that even fish life, which in general may be said to require about 50% dissolved oxygen, is not likely to be seriously affected. (N. B. This refers to the water of the main channels only.)

Warm Weather Determinations

The significant determinations are therefore those made during the warm months and for our purposes those confined to the months of June, July, August and September only have been compiled, the averages at certain stations being as follows:

	1909* Pct.	1911* Pct.	1913* Pct.	1914 Pct.	1915 Pct.	1916 Pct.	1917 Pct.
The Narrows	83	76	69	68	78	63	63
Upper Bay-Robbins Reef	67	72	66	71	72	64	50
Hudson River	72	62	57	50	42	46	42
Harlem River	55	42	29	30	28	24	22
Upper East River	86	69	..	50	..	..	47
Lower East River	65	54	43	40	33	26	29

*A few of these were tested between October 1 and June 1.

The data show graphically the general increase of pollution in the harbor, stated roughly, we may say that in the Harlem River and the East River there is but half as much dissolved oxygen in summer as there was in 1909, and in the rest of the harbor but about three-fourths as much as in that year. The increase in population during this period directly tributary to the harbor (omitting New Jersey), which is the chief contributing factor in the depletion of oxygen, is shown in Table I.

TABLE I—ESTIMATED POPULATION OF NEW YORK CITY DIRECTLY TRIBUTARY TO CERTAIN BRANCHES OF THE HARBOR

	1909	1917	% Increase
Upper Bay and Narrows	526,000	712,000	35
Hudson River, Lower	711,000	855,000	20
Harlem River	620,000	833,000	34
Lower East River	2,107,000	2,709,000	28

Minimum Saturations

Now, while odors may occur with the discharge of large volumes of septic sewage or by the generation of gas bubbles by fermentation of the underlying sludge, they are not produced in polluted water until the dissolved oxygen is entirely used up. The change is then rapid to the putrefactive stage with its repulsive odors. The importance of avoiding this condition is evident, and it follows that minmum saturations are of prime significance. These, for several points in the harbor, are given in Table II.

TABLE II—MINIMUM DEGREE OF SATURATION WITH DISSOLVED OXYGEN OBSERVED AT CERTAIN STATIONS IN NEW YORK HARBOR

	1909 Pct.	1911 Pct.	1912 Pct.	1913 Pct.	1914 Pct.	1915 Pct.	1916 Pct.	1917 Pct.
The Narrows	65	62	61	43	45	54	48	46
Robbins Reef	62	64	53	38	70	58	51	42
Hudson River—								
Pier "A"	57	19	51	25	31	25	29	25
155th St.	55	57	..	..	36	22	25	20
Spuyten Duyvil	55	68	..	50	64	35	28	..
Harlem River—								
Morris Heights	..	46	..	..	6	8	..	1
Willis Avenue	54	29	..	..	0	6	1	0
Lower East River—								
23rd Street	52	..	..	39	28	19	8	10
Pier 10	52	49	49	13	19	22	17	19

Conclusions

As the worst conditions naturally occur near sewer outlets and at other points near the shore where currents are retarded and where deposits of sludge have formed, we may infer from these figures that:

a. The conditions in the Lower East river and the Harlem river are such that local nuisances from foul odors may be looked for at any time after several days of very hot weather.

b. The conditions in certain parts of the Hudson river and of the Upper East river are approaching those that already obtain in the Lower East river.

Some Specific Suggestions on the Drainage of Roads

An essential feature of an improved road is adequate drainage, according to the specialists of the Bureau of Public Roads, United States Department of Agriculture. Thorough drainage is so necessary that it is practically impossible to maintain satisfactory roads unless it be given proper attention. Another prime requirement wherever a hard surface road is to be constructed is a firm and unyielding foundation. As the quality of the soil has an important influence on the proper method of drainage and the type of foundation to be employed, much care and study must be devoted to the nature, type, and character of the soils in the section through which it is proposed to build a road.

The most important primary soils are classified as gravel, sand, and clay, but often many of the secondary or mixed soils, because of their more general occurrence in connection with road-building operations are equally important. Such types as loam, marl, gumbo, and hardpan are representative of this order.

Drainage Structures

In the design of a road the drainage structures are planned to take care of water and under three general conditions—rain that falls on a road surface or grade; rain that falls on contiguous land and grows in accumulated volume towards the road; and ground water from any immediate source. To meet these conditions use is found for special structures, including longitudinal side ditches, usually parallel, or approximately parallel to the center line; intercepting ditches to accommodate water whose approach so close to the roadway as the side ditches is likely to cause injury; lateral ditches or culverts to conduct accumulated water away from or under the road; and subdrains. In order to plan intelligently a system of drainage for any particular road, it is necessary to consider not only the local character of the soil composing the roadbed, but also the topography of the adjacent land, the amount and rate of rainfall and the availability of material suitable for use in constructing drains.

Provide Surface Drainage Systems

Surface drainage systems for roads consist of side ditches along the road, paved gutters (which are a development of side ditches and replace them) open intercepting ditches constructed to prevent water from reaching the road, and lateral or relief ditches to carry off the water which collects in the side ditches or in the intercepting ditches. Culverts and inclosed drains, which are constructed for the purpose of removing storm water from the side ditches or gutters, are essentially a part of the surface drainage system, and are not to be confused with subdrains which serve an entirely different purpose.

Where the grade of a road is so steep that the ordinary earth side ditches can not be maintained satisfactorily at a reasonable cost, or where earth side ditches would be insanitary or appear unsightly, it is customary to provide paved gutters for removing the surplus water. The point at which it is economical to change from earth side ditches to paved gutters on account of the steepness of the grade depends on the character of the soil and the amount of water to be carried.

Gutters

Gutters may be constructed of Portland cement, concrete,

brick, cobble stones, angular fragments of stone, or other material. In some cases they are formed simply by constructing a curb along the edge of the road surface, as is done sometimes in city pavement construction. This method can be employed only where the road surface is made of material capable of withstanding the eroding action of water and where it is not important that the earth shoulders be kept open to vehicle traffic. Gutters are made from 2 feet to 6 feet wide and from 3 inches to 10 inches deep, depending to a great degree on the type of design, and the size is governed by the same consideration as governs the size of earth side ditches; that is, they should have a cross section sufficient to drain the road without danger of overflow, and in order to determine this cross section it is necessary to consider the area drained, the maximum rate of rainfall and run-off and the character and slope of the gutter.

Inlets and Catch Basins

Drop inlets and catch basins are used to conduct water from side ditches or gutters into under-ground drains or culverts. On country roads they are used most frequently on side hill locations where the water collecting in the upper side ditch or gutter can be removed from the road at intervals by means of a culvert across to the lower side. Drop inlets usually are sufficient, and catch basins seldom are used in country road work, except where it is especially desirable to prevent the silt and other foreign material carried by the water from getting into the underground drainage structure.

Open Ditches Used in South

Open ditches have been used frequently in some of the Southern States for subdraining roads through low, flat sections. Ordinarily only one ditch is used, and it is located a few feet outside of and parallel to the road. This ditch usually is made about 2 ft. wide and 3 to 4 ft. deep, with vertical banks. The material excavated from the ditch is used to build up the roadbed, and the surplus water from the side ditches is turned into the deep ditch at convenient intervals. The use of such ditches should be decided upon with care. There are ditches in the South, within the coastal plain, where sand clays and indurated clays occur a few inches underground that have stood with vertical sides since the middle of the last century. They have been cleaned repeatedly and no doubt have become somewhat enlarged, but considering the cost of maintenance and the service given, they have been entirely satisfactory. In other soils of a gravelly nature, however, the sides of such ditches would not stand, and the cost of keeping them clean would be excessive. In certain localities the open ditch soon will become obstructed by the banks breaking away and by the growth of vegetation, and is very seldom economical in the long run.

Filled Ditches

Ditches filled with broken stone or gravel sometimes are used as a substitute for tile drains. These have been used in all sections of the country, and when properly constructed usually have proved satisfactory for a considerable period of time. When such ditches are used it is common practice to place one on each side of the road immediately under the ditches. They are excavated to a depth of 2 to 3 ft. with vertical sides and usually are made about 18 ins. at the top or just wide enough for a man to work in them conveniently. To be effective they must have a uniform grade and be carried to a suitable outlet.

Tile Drains

Tile drains in general are much superior to either open ditches or ditches filled with stone for subdraining roads, and though generally more expensive than either open or stone drains, they usually can be constructed at comparatively small cost. As a rule the tile need never be over 6 ins. in diameter, while for ordinary conditions a diameter of 4 ins. is sufficient.

Firm Foundation Essential

The purposes of a foundation are to aid in distributing the pressure due to wheel loads concentrated on the road surface, so that the intensity of pressure on the subgrade will not exceed a safe unit-bearing power, and also to prevent, if possible, the crust of the road from being disturbed by the upward pressure of the subgrade due to the action of frost, ground water, or other disturbing influence. In the case of a pavement consisting of comparatively small blocks, such as vitrified brick, bonded to each other very slightly or not at all, an entire wheel load might be concentrated on only a few square inches of foundation, in which case it would be necessary for the foundation to take care of practically the entire distribution of the load. On the other hand, a monolithic pavement, or a pavement in which the individual units are well bonded together, might distribute the wheel loads to obviate all necessity of further distribution by the foundation, and if adequate drainage were provided and there were no danger of heaving of subgrades, the foundation might be omitted entirely.

Maximum Wheel Loads

The heaviest vehicle that ordinarily has passed over a public highway heretofore is the 15-ton traction engine. Such engines are so designed that the rear axle carries about two-thirds of the total weight, which arrangement gives a concentrated pressure on the road surface of about 5 tons under each rear wheel. The use of much heavier equipment is in sight, however, and unless some regulations be passed to prohibit it, the occurrence of 10-ton or even heavier motor trucks may become common on highways adjacent to large cities or between large centers that are only a few miles apart.

In assuming the maximum wheel load for any particular road a reasonable allowance should be made for future increase. Since motor trucks have come into use there has been a constant tendency to increase both their rates of speed and the loads they carry, and it is probable that this tendency will continue. Furthermore, many roads not now subjected to motor truck traffic will attract such traffic after they are improved, and this possibility always should be considered. Increase in the volume of traffic also may be an important factor, because a foundation ample to support an occasional load might fail soon if the same load were often repeated.

Procedure in Constructing an Open Joint Wood Block Pavement at Toledo, Ohio

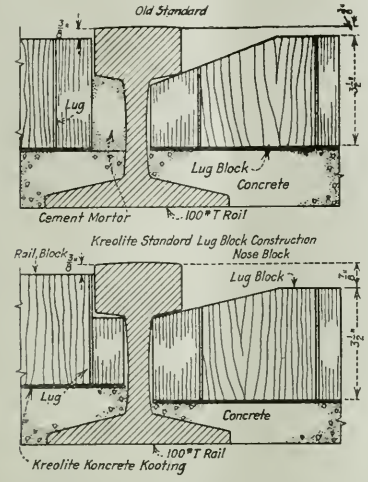
By Raymond Pierce, Construction Engineer, Russel & Jennison Co., Toledo, Ohio

The city of Toledo, on August 17, 1917, awarded a contract to the Russell & Jennison Co. to pave Dorr street with about 40,000 sq. yds. of Kreolite lug wood block. Delay in signing the contract prevented the work commencing until September.

VIEW OF DORR ST., TOLEDO, OHIO, AFTER PAVING WITH KREOLITE LUG WOOD BLOCK.

Because of an extraordinarily early winter, snow setting in on the 12th day of October, and the continuously bad weather thereafter, the work was delayed to such an extent that not much was completed before spring.

In order to carry on the work during the winter months, it was necessary to use a tractor to steam the stone and sand and to furnish hot water for the concrete mixer. The concrete was laid in this way during the winter months and covered with straw until the thermometer registered about 20 degs. above zero.



OLD AND NEW STANDARD WOOD BLOCKS ADJACENT TO RAILS, DORR ST. PAVEMENT, TOLEDO, OHIO.

On 2,100 lin. ft. of this street, an old Medina stone pavement, which had been laid upon a sand cushion, was taken up and replaced with a 6-in. foundation of concrete. Upon this 3½-in. Kreolite lug blocks were laid over a ½-in. cushion of sand-cement mortar. The interstices of the blocks were filled about one-quarter full with fine, dry sand, the balance being filled with hot pitch. The remaining 7,500 ft. was originally an old asphalt block pavement laid upon a 6-in. natural concrete foundation. Because of the poor condition of the concrete on this section, it was decided that the worn places or holes should be thoroughly cleaned and brought to the proper grade with new concrete.

The crown of the street was changed from 6 to 4 ins. and 2½ ins. of new concrete was placed over the old 5½-in. natural cement concrete foundation. The new concrete topping was struck off with a template, floated with a Ransom concrete roller and finished smooth by hand with an ordinary wooden float. This surface was then allowed to dry for seven days and a very thin mop coating of pitch was applied, with Kreolite lug block laid directly upon the same after allowing the pitch to harden.

Filling Joints

On about 2,200 ft. of this section the interstices were filled with about ¼ in. of fine, dry sand, the balance being filled with pitch. Fifty-three hundred feet of this section had the interstices of the blocks filled with sand about two-thirds full, the remaining one-third being filled with one application of hot pitch.

In the pitching of the joints the best results were secured by the use of a squeegee made with a ½-in. strip of pure gum rubber.

Paving Car Tracks

About 3,000 lin. ft. of the car tracks were laid with a 7 in. concrete base upon which were placed 6x8x7 untreated oak ties on 2½-ft. centers. One-hundred-pound American Railway Engineering Association rails were used on this work. Upon this concrete base and under the ties was tamped 3 ins. of crushed stone. After thoroughly tamping the stone, an additional 6-in. concrete foundation was laid, which was given a smooth finish and a coating of pitch, directly upon which were placed 3½-in. Kreolite Lug Wood Blocks, the wearing surface of the blocks coming ⅞ ins. below the inside of the head of the rail and ⅜-ins. below the outside of the head of the rail. About ¼-in. of dry sand was then applied as a filler to act as a dam to prevent the pitch from floating the blocks, and the balance of the interstices completely filled with pitch as above described.

Concave Track Paving

An unusual feature of this construction was that instead of crowning the wearing surface between the rails and between the tracks, as usual, the finished roadway was concaved ¾-in. to permit the water to run more readily away from the rails to the center of the tracks or dummy.

The remaining 6,600 ft. of tracks was laid with steel ties as manufactured by the International Steel Tie Company of Cleveland, Ohio. Six steel ties were placed to every rail in the tracks and the ties electrically welded to the rail. The bolts were all spotted at the nut to avoid working of the joints. The track was then placed in an 18-in. concrete foundation, finished smooth and the blocks laid as above described.

The Nose Block Used

On this section of track 3,400 ft. were laid with the old style nose block, and 3,200 ft. with the new style Kreolite lug nose block as shown in the accompanying drawing. It will be noted that the new style nose blocks were placed ⅞ ins. below the top of the inside head of the rail, while the old style nose blocks were placed ⅜ ins. below the top of the inside of the head of the rail. It was found that by placing the new style nose blocks in this way, the trouble caused by the flanges of the heavy interurban cars reaching out and cutting the ends of the blocks was eliminated.

Fifteen hundred feet of double track were laid with Kreolite rail blocks. These rail blocks were found to give very excellent results on the outside of the outside rail and on both rails of the dummy, in avoiding the possible working up of the blocks alongside the rail.

Handling the Filler

Considerable trouble was experienced during the summer of 1918 because of the bituminous filler being applied too heavily the fall previous. When warm weather arrived the pitch became obnoxious and it was necessary to sand the pavement several times. The engineers in charge of the construction immediately cut down on the amount of pitch used on the balance of the pavement, increasing the quantity of sand first applied to the interstices as a dam, to a depth of about 2½ to 3 ins. and filling the balance with pitch. This method of construction caused trouble from obnoxious exudation to cease.

Because of the heavy application of the filler, in a few instances the blocks first laid "floated," particularly along the car rail. This is a strong argument against the application of too much filler. It demonstrates the necessity of first placing a sufficient dam of dry sand to prevent the possibility of the pitch geting underneath the blocks.

With this new method of construction, blocks are first firmly keyed to the smoothly finished concrete foundation and it is impossible for the sand filler, which is first applied, to affect or disturb the permanence of the cushion.

This open-joint method of construction not only waterproofs the surface of the pavement by the application of the pitch filler, but also waterproofs the under side of the blocks, thus thoroughly sealing each individual block of the pavement on five sides, transforming a multiple into practically a single unit pavement. The coating of sand which is finally applied to the pavement is ground into the upper fibers of the blocks and interstices between them.

A Review of Modern Steam Shovel Practice, with Recommended Procedure

By Capt. Llewellyn N. Edwards, Supervising Engineer of Bridges, Toronto, Ontario

Modern methods of earth excavation are sometimes said to have originated in war—in the building of the Roman military highways and fortification for the defense of all parts of that ancient, world-conquering empire.

While these works were doubtless among the most important activities of the Roman military engineers, it will be admitted by any one who gives this matter careful consideration that the claim mentioned above is at least far-fetched. In so far as Canadian and American practice is concerned, it must be recognized that our most modern methods represent a consistent development of less than half a century, and nothing could be more certain than that it has been very closely allied with the enormous strides made in the methods of transportation—from the horse-drawn vehicle to the high-speed steam locomotive and the electric and other motors.

Capacity Doubled in Two Decades

No doubt one of the most important factors in modern methods of construction has been the development of the power-driven excavator commonly known as the steam shovel, although this term is more or less a misnomer, since many of these machines are operated by electric power. This development has been measured by the requirements of their use, and has kept step with the constantly increasing demands of economy and efficiency. In this connection it is especially interesting to note that within the last two decades the operating capacity of the largest shovels has more than doubled. This increase, although rapid, has been gradual and at all times amply justified by previous practice.

Experience has fully proved that whatever is feasible or desirable from a commercial or economic standpoint can be built from a mechanical standpoint. It follows, therefore, that the limits of the size of a shovel are dependent upon the magnitude of the work it must perform to insure its profitable employment, and upon the facilities available for the disposal of the excavated material.

The various types of shovels are dependent for their characteristic features upon the classes of work for which they are designed. Steam shovels are now mainly employed upon excavations incidental to the construction of railways, highways, canals, sewers and ditches, in quarries and mines, and in the making of excavations for bridges, buildings, etc. However, there is an ever-growing field of usefulness, and from time to time work requiring special features of design and adaptability are coming into view.

Fixed or Rotating Bodies

1. Those having a fixed main body, upon one end of which is installed a boom and dipper so arranged as to be capable of being swung horizontally through an angle varying from one-half to two-thirds of a complete circle, the angle of swing being mainly dependent upon the construction of the jack-frame of the shovel. The remaining portion of the fixed body is equipped with the operating machinery, power plant, etc.

2. Those having the entire shovel body mounted upon a turntable, which renders it possible to rotate the body, including the boom and dipper, horizontally through a complete circle, the boom having no horizontal movement independent of that secured by revolving the main body of the shovel.

Shovels used for railway construction work are almost invariably built to standard gage and are equipped with air brakes and other standard appliances necessary for coupling them into freight and work trains.

Wide Tread Wheels Preferred

Shovels used for highway, canal, sewer and other ordinary work may be constructed with trucks, which adapt them to movements upon standard steel rails, or they may be provided with wide tread traction wheels. In general the latter are preferred, since the wide tread wheels are best adapted to varying soil conditions.

Economy and efficiency of shovel operation are mainly dependent upon a properly proportioned combination of the latent power of the machine with the brains and experience of the operator. Broadly speaking, shovel operation may be divided into two phases:

1. The movement of the entire machine longitudinally, transversely or otherwise, as the physical requirements of the work may demand.

2. The manipulation of the dipper and boom incidental to the actual excavation of the material.

Assuming that transportation facilities by cars, wagons or other means are ample for the removal of excavated material to the full working capacity of the shovel, and that this service is as nearly continuous as possible, the output of the shovel is mainly dependent upon (a) the efficient operation of the dipper and boom and (b) the movements of the entire machine incidental to the enlargement of the excavated area.

Moving the Shovel—Horizontal movements of the shovel are accomplished in several ways. The importance of making the "move up" in the least possible time is far too frequently underestimated. However, the thoroughly efficient shovel operator fully realizes its relation to the total excavated yardage handled in a given length of time.

Movements on Rails—Whenever the shovel is to be transported comparatively long distances under its own power, the simplest form of track outfit consists of short sections of rails spiked or bolted upon wooden sills or stringers. The rails are maintained at proper gage by means of eyebolts and cramps. Details of this form of track section are shown in Fig. 1. Increased distribution of the wheel loads is generally provided, when necessary, by the use of transverse "mud sills" placed at intervals under the rail sills. The safe movement of a shovel down a grade requires that the track sections be secured

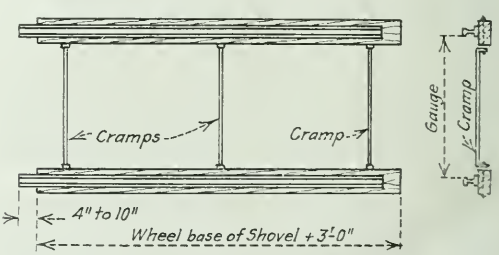


FIG. 1. TRACK SECTION FOR LONG DISTANCE MOVEMENTS.

against longitudinal movement by the use of rail splice plates or other appliances.

Economy effected by the use of track of this type, as compared with track of ordinary construction, is readily apparent.

To facilitate the "move up" of the shovel in the operating pit, somewhat shorter sections of track than those shown in Fig. 1 must be used. The length of rail is somewhat dependent upon the size of the shovel, but in general it should be equal to the length of the average "move up" distance.

Very Useful Track Section

The track section shown in Fig. 2 is well adapted to a wide range of service conditions. The joint ties perform a two-fold function—the elimination of splice plates and bolts and the distribution of the wheel loads over a considerable area. The rails are held in place by the rail clips and coupling pins. The holes in the rail clips should be slightly slotted to facilitate the engaging of the holes in the rails.

Movement of joint ties is facilitated by the use of hooks or

other specially devised carrying devices, for which purpose eye-bolts are provided in the ends of the ties.

Movements on Wooden Skids—Movements of the shovel on a wooden track are adapted to the use of shovels equipped with traction wheels. Usually the track consists of a double course of planks or lagging, the upper course of which is laid longitudinally or workwise with the direction of movement of the shovel. These are commonly called "running planks." The lower course of planks is laid transversely to the upper and serves to distribute the wheel loads on soft or uneven ground.

The upper and lower course planks may be used as detached pieces or they may be assembled into built-up track sections, as shown in Fig. 3, for use in conjunction with the shovel of the turntable class.

Whenever built-up sections are used, they are moved to and from their location in the track by being lifted upon the dipper arm, a sling chain being provided for this purpose. Doubtless the most important factor upon which the successful lifting, swinging and dropping of the track sections into correct position depends, is the expertness of the shovel operator. However, this is a detail in which a careful operator should be able to attain efficiency by a comparatively small amount of practice.

Tough, Hard Timber Required

The timber used must be tough and comparatively hard. The former property prevents splitting, while the latter facilitates "skidding" of the wheels when turning the shovel or changing the direction of the cut.

Movements without Track—Shovels of light weight having traction wheels are occasionally operated without the use of track. In general the two conditions under which such operation may be undertaken are:

1. Upon a pit bottom consisting of a naturally cemented gravel or sand, shale-like clay or other exceptionally firm material.

2. Upon a comparatively firm pit bottom and with a shallow cut, rendering a "move up" necessary at short intervals.

Competent pit men contribute very greatly to the effective and satisfactory moving and operating of the shovel. One of their most important duties is the proper leveling and compacting of the pit bottom preparatory to the laying of track sections for the "move up." If this work be improperly done, the track will take an irregular bedding, which tends to increase the wear and tear upon the track sections, and also, by reason of track deformations, produces irregularities in the working functions of the shovel. A hardpan or a broken-stone pit bottom involves a quite different class of preparation from that composed of soft, yielding earth, upon which an allowance must be made for settlement and possibly for localized soft spots.

Turning the Shovel—Turning movements are commonly effected by a series of forward and backward movements, by which the alignment of the shovel is gradually changed to conform to the desired alignment. Railway and other shovels moving upon steel rails are deflected from a previous alignment by the use of curved track. Shovels equipped with traction wheels change direction by the use of a steering appliance which swings the forward wheels in the direction desired for any given movement.

Revolving shovels mounted upon traction wheels are equipped with the steering appliance mentioned above, but shovel operators quite frequently prefer to alter the alignment of the shovel by a series of sliding movements, commonly known as "skidding the shovel," in which the entire machine is swung about by a slight longitudinal movement. Possibility of breakdowns or unlooked-for accidents is not appreciably increased, provided the movement is executed with reasonably good judgment and care.

Skidding and Its Advantages

When a shovel is placed in proper position for "skidding" a rear wheel is trigged to prevent a forward movement and the other wheels are free to move both forward and sidewise. The dipper is thrust vertically downward and takes a firm, even bearing upon the pit bottom, the dipper arm being subjected to a slight pressure, which has the effect of tending to raise the boom.

Immediately upon the completion of the above preparation, the shovel is subjected to a combined swinging and traction effort. The shovel body is swung slightly. This movement, combined with the forward tractive effort, subjects the vehicle portion of the shovel to a thrusting force, which produces a lateral slipping of the nearest front wheel and a combined lateral and forward movement of the wheels on the opposite side of the shovel. The nearest rear wheel executes a slight pivotal movement, but, being trigged, remains otherwise stationary.

Turning the shovel by this method possesses three advantages especially worthy of mention:

1. The area required for the execution of the movement is small in comparison with that required for a movement involving the use of the steering appliance.

2. The time and labor elements are reduced to a minimum.

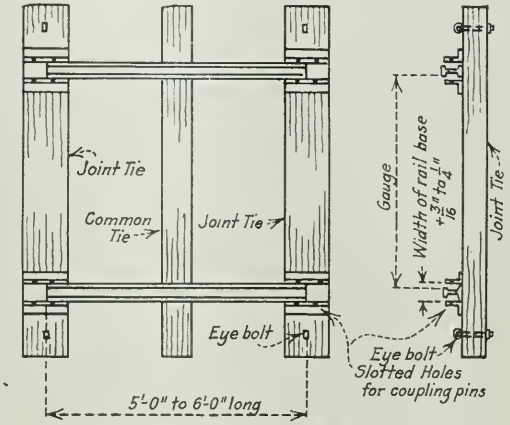


FIG. 2. TRACK SECTION FOR MOVE-UP IN PIT.

3. The excavation of material is continued throughout the execution of the movement at a rate only slightly reduced below normal.

Dipper and Boom Operation

The composition, physical properties, etc., of the material to be excavated constitute important factors entering into effective dipper and boom operation. A brief consideration of natural soils, including rock formations, is therefore essential to a discussion of the functions affecting the efficient operation of these members.

Broadly considered, natural soil materials are divided into five general classes: Rock, gravels, sands, clays, and ordinary soft soils and earths.

Rock varies in its physical properties from the granites, syenites and other hard crystalline rocks, to the sandstones, conglomerates, shales and other comparatively soft rocks of sedimentary origin. Rock formations must generally be broken into comparatively small fragments by blasting before they can be excavated with a steam shovel. However, very soft sandstones, conglomerates, shales and other rocklike material commonly known as "rotten rock," can frequently be excavated without blasting.

Gravels vary widely in composition and texture. A coarse gravel firmly cemented with a natural earthy cement containing iron, lime or other cementing material, may require to be blasted before being excavated; while on the contrary, a loose, disintegrated gravel may be freely excavated without previous preparation.

Sand-like gravel varies widely in composition and texture. It may exist as hard, practically cemented material or, when saturated with water, as a soft, unyielding, semi-fluid material.

Clay varies in its physical composition from that containing a considerable amount of fine, sandy material to that which is commonly known as "gumbo," in which there is no sand. It may exist as a firm, solid material of great cohesion and density, closely resembling shale rock, or as a pasty, semi-fluid material which will squeeze and ooze under pressure.

Soft soils and earths commonly contain vegetable matter. Swamp deposits of peatlike soils are almost entirely of vegetable origin.

From the above consideration of the diversified character of natural earths, it is clearly apparent that the operation of the dipper and boom is especially exacting, demanding the closest attention and skill on the part of the operator. The operation of the dipper involves two primary movements:

(1)—A thrusting, commonly termed "crowding," movement by which the dipper is forced into the material; and

(2)—A vertical or lifting movement by which it is drawn through the material.

To these may be added a horizontal swinging movement, which is secondary in its nature, since it is produced by a swinging movement of the boom rather than by the dipper-operating machinery. The thrusting and lifting movements are almost invariably applied simultaneously.

A fully loaded dipper accomplished by the least possible effort and in the least possible length of time is the primary object sought by the operator. To this end he directs all dipper movements. However, the magnitude and the speed of the thrusting and lifting movements are influenced to a marked degree by the physical character of the material. A dense, hard and uniformly firm material (for example, a shale-like clay) can be successfully excavated only by a comparatively slow thrusting and lifting movement, giving sufficient time for the fracturing of the material. In comparison, a very tough but comparatively soft clay "cuts like butter" when the dipper is operated to "peel it off" in thin slices.

Rock, when well broken by blasting, involves no special consideration apart from that adapted to ordinary materials. Rock excavation from which large irregular fragments must be removed, demands a rather different treatment. These fragments must be adjusted in a manner which will permit them to pass through the dipper when delivered or, if too large to permit this, they must be so poised upon the dipper teeth as to permit of their removal with the least possible effort and loss of time.

The above conditions can be most effectively met by the operator who by using a certain amount of foresight aims to load each dipperful in a manner which will prepare the way for securing a succeeding dipperful. By the exercise of good judgment, the large fragments are thus shifted about to positions from which they are caught within or upon the dipper with least difficulty and effort and with practically no loss of time.

Adjustments of the Boom

The position of the boom (i. e., the angle it makes with the horizontal), has an important bearing upon the service operation of the shovel. When the boom supports are adjusted to their full length, the boom "swings low" and the dipper is correspondingly affected by an increase in its "reach" and a decrease in its "clear lift." A shortening of the boom supports produces correspondingly opposite results.

Apart from the "reach" and "clear lift" conditions of the dipper mentioned above, the adjustment of the boom may be made use of for the purpose of balancing or poising the dead load of the shovel combined with the dipper live load when the latter is engaged in filling and swinging operations. In this connection, it must be borne in mind that the boom and operating machinery stresses are increased by a lengthening of the boom supports.

The delivery of the dipper is effected by a swing of the boom or by a rotation of the shovel body, according to the class of shovel used. To be most effective, the complete operation must be executed as a practically continuous movement. This is commonly accomplished by permitting the dipper to coast free of swinging engine action over a short distance at the end of the delivery swing, thus permitting the engine cylinders to become free of steam and in complete readiness for the reverse movement, which returns the dipper to the desired position for reloading. Coasting the dipper, as herein described, relieves the boom, swinging engine and other appliances from the shock and impact stresses which would result if the swinging engine remained in operation up to the instant the dipper delivery movement were completed.

Cars, wagons or other appliances used for the transportation of excavated material may be subjected to injury as a result of carelessly executed dipper delivery. This condition applies especially to rock excavation work.

In all dipper and boom operation, the operator should aim to eliminate excess movements involving losses of energy and time. In this connection a practical application of the theory of "motion study" will accomplish surprising results. The most common sources of loss are (a) failure to land the dipper in a position from which the thrust and raise movement can immediately be begun; (b) failure to stop the upward move-

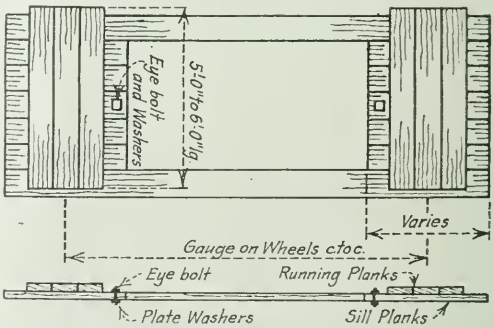


FIG. 3. BUILT-UP WOODEN TRACK—ALL PLANKS BOLTED OR SPIKED IN PLACE.

ment of the dipper immediately upon the completion of the filling operation; (c) failure to properly adjust the elevation and distance locations of the dipper during the operation of swinging, in readiness for the delivery to cars or other transporting vehicles; and (d) failure to release the dipper door immediately upon its arrival in position for the delivery of its load.

Care of Shovel Machinery

Successful shovel operation depends mainly upon the energy, skill and brains put into the work by the operator. The care which he bestows upon the engines and other operating parts is doubtless the most important factor.

Recognizing that a working shovel is the mainspring of the job, he will constantly be upon the lookout for loose nuts, broken bolts, and improperly adjusted gears, bearings, etc. He will "listen for knocks," well knowing that a loose bolt will produce a "knock," and that a "knock" unattended to is a sure forerunner of a "knock-out."

If, perchance, the "knock-out" materializes through ordinary and unavoidable wear and tear or otherwise, he will endeavor, by the exercise of trained intelligence, to accomplish such temporary repairs as will permit of continuing the operation of the shovel until such time as permanent repairs can be made without a complete tie-up of the work.

Reckless operation frequently takes the form of a sudden

application of full steam to an engine, the too abrupt application of a retarding or stopping force, or a too generous thrust of the dipper with the inevitable result that the operating parts of the shovel are subjected to excessive stresses and uncalled-for abuse. Naturally enough, the operating costs will be augmented as the result of breakdowns and repairs.

The writer desires to express his thanks for helpful suggestions received from W. L. Davis, whose long, practical experience in shovel operation has been of material assistance in the preparation of this article.

Acknowledgment

The foregoing article by Captain Edwards is here reprinted from a recent number of The Canadian Engineer because of its undoubted interest and value to American engineers and contractors.

Improving the Status of Municipal Engineers

To the Editor:

"I watch with very much interest the work done by the American Association of Engineers and give that organization due credit for bringing about a very marked improvement as regards the status of the engineer engaged upon railway work. The other evening I was talking with the superintendent of one of the trunk lines entering Savannah, and he expressed gratification at the work accomplished by the organization and approved their action in bringing about greater recognition of the importance of this branch of their service.

"At the time the local chapter was formed here I deferred joining the organization, being a member of so many societies that I felt my time, as much as could be spared, wholly taken up with other work. I notified the local secretary here then that I would be pleased to do anything I could to further the interests of the association and would be glad to join with it for the purpose of aiding engineers and others allied with this work.

"In connection with the work done for engineers, architects and others connected with railway work, I am very desirous to see a move taken by the engineering societies to further the project whereby there will be a Federal Public Works Department. Having been connected with the government for the long period of 21 years, I feel justified in expressing an opinion that public works could be better carried out by the organization of a department distinct and separate from the Engineer Corps of the army. The engineers engaged upon very important work are, as a rule, underpaid.

"Again, I am very much in favor of furthering interest in the city manager plan of government. Recently an association of city managers has been formed, and they are mapping out work which, I believe, will further the movement, which in my mind is fast becoming popular with many municipalities.

"Just so long as the people will stand for periodical decline in municipal management, so long will there be difficulty in obtaining capable and efficient engineers to accept uncertain and temporary employment with municipalities. I don't know that there is any section of the country that is worse than another as regards this matter. The public must be educated and must take more interest in city affairs to prevent the numerous occurrences where city management slips backward.

"Whether the real engineer, by organization, can assist in this important matter remains to be seen, but it should be the duty of the true engineer who becomes connected with a municipality to have it distinctly understood that he serves only with the understanding that politics will not enter in his work, and we have had a number of instances recently where good men resigned where it came to a point where the political machine came into control. By so doing, the time will come when the engineer will be more respected and will be viewed in a different light than he has been in the past.

"As stated before, it is my intention to become connected with the American Association of Engineers and to enter as a fighter for improvement, and I shall incorporate in my talk to the American Society for Municipal Improvements, at New Orleans, this fall, some ideas as to how the organization can take action and bring about improvements."

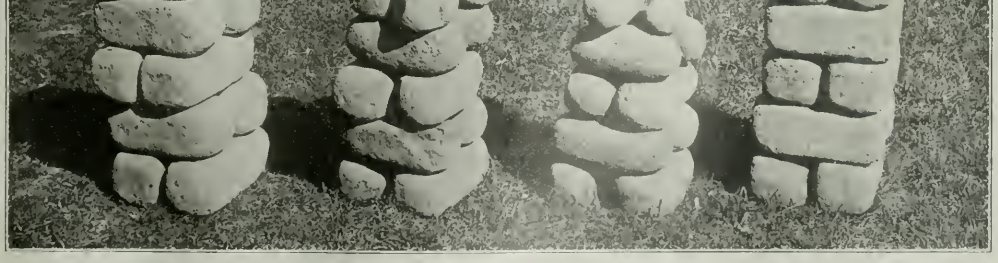
Very truly yours,

E. R. CONANT, Consulting Engineer,
April 15, 1919. 115 E. 31st St., Savannah, Ga.

Poor Brick Cause Pavement Failure—The Saving of $50 for Tests Leads to Failure of a $50,000 Job

By C. C. Wiley, Associate in Civil Engineering, University of Illinois, Urbana, Ill.

In 1913 the city of Champaign, Illinois, replaced a very rough, 30-year-old, two course brick pavement with one of a more modern type, consisting of 4-in. vitrified paving block on a 1½ in. sand cushion with a 6-in. concrete base.



VIEWS SHOWING COMPARATIVE RESULTS OF RATTLER TEST OF GOOD AND BAD PAVING BRICK AT CHAMPAIGN, ILLINOIS.

No. 1	No. 2	No. 3	No. 4
Ave. 13.1	Ave. 30.7	Ave. 47.7	Max. 13.2
Max. 16.0	Max. 41.1	Max. 100.0*	Max. 13.2
Min. 10.6	Min. 23.1	Min. 25..6	Min. 9.7

*The largest fragment weighed only 9.5 ounces, considerably less than the one pound fragment permitted by the specifications for the rattler test.

The brick used were of two kinds. About one-third of the project was laid with a brick much used in that locality and of known excellent quality. Due apparently to the inability to secure a sufficient number of these brick at the desired time the remainder of the job was laid with another brand of brick, which also had been used to some extent and was known to be rather erratic in quality. For some reason, however, no tests were made on these bricks although facilities for so doing were easily available at the University of Illinois, within less than a mile of the job, and a sum of $50 would probably have covered the expense of having a sufficient number of tests made.

No Tests Made Before Construction.

The street in question, East University Avenue, is the main thoroughfare leading from the business district of Champaign and the railroad stations toward the university and the city of Urbana. It consequently carries a large amount of fast motor traffic in addition to a considerable amount of moderately heavy teaming and trucking traffic.

Almost immediately after completion the portion laid with the second brand of brick began to show signs of wear. By 1918, the year the guarantee bond expired, this section had become very rough, numerous small pot holes had developed, and the whole surface was wearing very rapidly. In contrast to this the section laid with the first brand of brick exhibited a smooth, even surface and practically no wear on the brick.

Tests Made After Failure.

Although it seemed evident that the fault lay in the brick, and was not due to foundation or cushion trouble, it was decided to make some investigations to establish the fact definitely. Accordingly a number of openings were made, the cushion and foundation examined, and samples of the brick secured for testing. In none of these openings was there any evidence of substructure trouble but in every instance where the second kind of brick were used they showed unusual wear, amounting in some cases to nearly half the depth of the brick.

Tests at Right Time Would Have Thrown Out Poor Brick

Samples of the brick were taken to the highway laboratory of the University of Illinois and submitted to the standard rattler test, each brick being marked for individual record. All samples of the first variety of brick showed average losses well under the 23% fixed by the specifications, in fact no individual brick reached this amount. Of the second brand of brick, however, only two samples showed an average loss of less than 23% and even in these a number of brick showed individual losses much greater. The other samples all showed average losses much in excess of that permissible and many single brick showed extremely excessive losses. Without doubt had proper tests been made at the time of laying the pavement these brick would have been rejected.

One of the accompanying photographs shows four of the samples after testing. The two end piles are average samples of the first brand of brick, the second pile is an average sample of the second brand, while the third pile shows the worst specimen of these brick. The other views show some of the holes that developed in about 4½ years, due purely to wear of the brick.

Based on these investigations an agreement for replacement was made, involving of course only the second brand of brick. Two car loads of new brick were received but this time tests were made to determine their quality and also by means of individual records to establish if possible some percentage basis for culling. The results of these tests, however, proved rather curious. There appeared to be no relation whatever between the rattler loss and the color, weight, shape or absorption. In short, there seemed to be no certain method of properly inspecting and culling the brick and consequently all were condemned. Meanwhile no replacement has been made, the pavement is rapidly growing worse, and the traveling public, as well as the property owners who paid for the pavement, are complaining.

Saving $50 at Cost of $50,000

This experience shows anew the folly of permitting the use of materials of unknown or questionable quality without careful investigation, tests, and inspection to insure their suitability, and also how the "saving" of perhaps no more than $50 to the "tax payer" may result in the ruin of a job costing $50,000 or more, as in this case, in which the people are investing their money.

VIEWS OF BRICK PAVEMENT ON UNIVERSITY AVE., CHAMPAIGN, ILL., SHOWING HOLES WORN IN SOFT PAVING BRICK AFTER 4½ YEARS OF SERVICE.

The Sewage Disposal Problem in Chicago

By C. D. Hill, Engineer, Board of Local Improvements, Chicago, Ill.

Sewage disposal in Chicago is by the dilution process. The raw sewage of Chicago and its environs is discharged either directly into the main channel of the sanitary district of Chicago, or indirectly by means of the Chicago river, its branches, or other adjuncts of the drainage system. None of the sewage from the territory extending from the northern limits of Cook county to the state line of Indiana is discharged into Lake Michigan, with the exception of that from a portion of the city of Evanston, where intercepting sewers are now being constructed that will divert this sewage from the lake to the north shore channel, and with the exception of sewage contaminated water from the Calumet river. The Sag channel, which is nearing completion, and the Calumet Intercepting sewer system, which is now under construction, will eliminate this source of contamination. There still remains a very serious source of contamination from the sewage from the municipalities of northern Indiana bordering on the shores of the lake.

The intakes of the water supply of Chicago are so located that the water is usually quite pure, but because of possible

contamination the water is sterilized by chlorine so that one may drink the water without danger.

The completion of the present projects would seem to provide a complete solution of the sewage disposal problem, but, because of the growth of the city and because of the changing conditions, we will find that new projects and new methods will be needed before the present works are fairly completed. This has happened several times in the past.

Important Work Now in Progress

At the present time intercepting sewers are being built in the city of Evanston, which will divert its sewage from the lake to the North Shore channel.

In the Calumet district work has been in progress for some years on the construction of the Sag channel which will connect the Calumet river with the main channel of the sanitary district. This channel is necessarily small in capacity, while the storm flow of the Calumet river at times is very great. This makes it necessary to divert all sewage from the Calumet river, and intercepting sewers are now being built which will accomplish this purpose, the sewers discharging into the Sag channel just below the point of connection with the river.

Unsettled Controversy with Federal Government

The act of the legislature, which provided for the construction of the sanitary district channel, required 300,000 cu. ft. of water per minute to pass through the channel for the purposes of dilution at the time the channel was first opened, and required 600,000 cu. ft. per minute when the population of the district should increase to 3,000,000.

The channel as originally built through the rock section had sufficient capacity for this maximum flow, and through the earth section, while its original capacity was that of the minimum amount, it has since been widened so as to provide for the maximum flow. When the channel was first opened a permit was granted by the United States authorities for a flow of 250,000 cu. ft. per minute through the Chicago river. This was supposed to be the maximum amount that could flow through the river at that time without interfering seriously with navigation. Since that time the river has been deepened and straightened and in some places widened so that with a maximum flow there would be little, if any, interference with navigation. The Federal authorities, however, insist that the limits of the original permit still apply and that there is serious objection to permitting an increase because of the danger of lowering the level of the lake. The fact that the level of the lake today is considerably higher than it was in 1900, when the channel was first opened, does not appear to affect the argument.

The experience of the past 15 years indicates that the rate of dilution recommended by the commission was barely sufficient to provide for the sewage from the population of the district. This rate, however, did not take into consideration the gross pollution from industries, and the actual condition of the water in the channel for the past few years has not been satisfactory, principally because of the vast amount of filth discharged into the channel from industries and particularly from the stock yards district. The pollution of the water that is discharged into the Desplaines river and Illinois river is sufficiently great to justify complaints from residents of the state living along the borders of the rivers; this is despite of the fact that at times a larger flow is maintained than was contemplated under the terms of the original permit from the Federal authorities. There is serious danger that the Federal Government will not permit the increased flow that is needed and may indeed restrict the flow to an amount that would be entirely inadequate.

These conditions have led to numerous negotiations with Federal authorities and to the instigation and prosecution of litigation, but no results have been obtained either from the negotiations or from the litigation. At the same time the sanitary district of Chicago has made continuous studies of the problem, particularly with respect to various methods of sewage purification that might be installed in case the Federal Government should not permit the necessary dilution. These studies were appropriate even though the Federal Government should permit the maximum flow through the channel, for the reason that the time is approaching when the population of the city will exceed that which was contemplated by the commission which recommended the present works.

The sanitary district has made a series of investigations as to the treatment of industrial waste and particularly the waste from the stock yards district. Definite conclusions have been reached as to the method of treating the waste from the stock yards district, and negotiatons are pending as to allotment of the cost of establishing and operating such purification works.

Present Situation is Critical

The situation today is quite critical. The Federal Government may restrict the flow from the lake so that it will be impossible to dilute the sewage to the extent required by the Act of 1889. Under this condition the state would be justified in objecting to the discharge of the grossly polluted water from the canal into the Desplaines river, and requiring the construction of supplementary works for treatment of the sewage. To build new treatment works, that would purify the sewage sufficiently so that with the limited dilution of lake water the effluent would not constitute a nuisance, would require years and would cost so much that it would be necessary to obtain legislation to sanction their construction.

People Unconcerned

There is a lack of appreciation on the part of the general public in Chicago of the seriousness of this situation. Few people realize the opposition of Federal officials to the operation of the channel in accordance with the original plan, and fewer realize the opposition to Chicago from the people of other cities along the Great Lakes. This opposition is due largely to a mistaken notion as to the effect of the flow of water through the channel upon the level of the lakes; nevertheless, it is real.

Treatment Works Must Be Built

If we should be so fortunate as to obtain from the Federal Government permission to operate the channel at its full capacity, it will be difficult to make the people of this community understand that, because of the growth of population and the consequent increase of pollution of water, it will be neecssary to install auxiliary purification works, and once more we will repeat history by showing by actual conditions the inadequacy of present methods long before new works can be installed.

One thing should be made plain, and that is that there has been made no serious mistake in the successive steps through which the sewage disposal works of Chicago have evolved, except the mistake of procrastination. Each step has been logical and reasonable, and to have attempted other methods would probably have been unwise.

Procrastination Only Mistake So Far

At the time the present works were planned there was strong argument on the part of a few progressive engineers that the construction of a large canal providing for dilution was unwise and extravagant, and that a much better plan would be to build sewage purification works. If such a plan had been followed, the method of purification adopted would probably have been obsolete before the work had been fairly started, and if Chicago could have changed its work as often as the engineering profession has changed its opinion as to the most effective method of sewage purification, the works would have undergone a continuous process of rebuilding.

The foregoing matter is from an address to the Sanitary Engineering Section of the American Public Health Association at the recent annual convention in Chicago.

Methods of Removing Crenothrix from Public Water Supplies—Chlorine Treatment is Successful

By W. F. Monfort, Consulting Chemist, 506 N. Vandeventer Ave., St. Louis, Mo.

In reviewing the methods of ridding infected iron-bearing water supplies from crenothrix it becomes apparent that 50 years of investigation have not fully explained the relation of the organism to the divers troubles associated with it.

Life Processes of Crenothrix

In the most recent classification crenothrix is thus described. "Filaments, unbranched, showing differentiation of base and tip, attached, usually thicker toward the tip. Sheaths plainly visible, usually colorless, brownish from iron oxide in old filaments. Cells cylindric to spherical. Multiplication by non-motile, spherical conidia; cells dividing in 3 planes to form conidia." (J. Bact. 3,305). Wolle (Fresh Water Algae of North America, 1887) said: "The peculiar colorlessness and gelatinous consistency of the plants suggest a relationship with some of the forms of filamentous fungi. Cobn and Zopf retain it as an algae."

Since the sheaths of its older filaments occur in iron ore deposits it has been thought to bear a casual relation to the formation of beds of soft iron ore, as in the Mesaba range. (U. S. G. S. Monograph 47, 826.)

The life processes of the organism are difficult to establish. Whether the segregation of ferric hydroxide in older but not vegetative threads is a source of energy (Winogradsky 1913), or a mechanical phenomenon not connected with the life processes of the cell (Molisch and Ellis) remains in dispute. Rossler reports the growth of crenothrix on porous porcelain in a ferrous sulfate solution.

Thresh, however, reports it as growing on potato moistened with a very dilute solution of ferric chloride. It is usually stated that no medium permits the growth of crenothrix in the laboratory. A possible explanation of these discrepant statements is suggested later.

Another suggested source of life-energy to the organism is in the carbon dioxide liberated from ferrous carbonate in iron bearing waters.

More definite knowledge is needed. As pointed out recently by Harder (1915) the isolation of the higher iron bacteria from the simpler ones, cocci and single-celled bacteria, and their study in pure culture are attended with great difficulty.

Nature of Trouble Caused

That in many instances bacteria of putrefaction accompany it and the life reactions of these and other bacteria may share in the changes usually attributed to crenothrix is evidenced by the obvious decay of its accumulated masses.

Since the water calamity in Berlin in 1878 there has been no doubt that crenothrix is associated with acute troubles in water supply systems, in that the organism, by its growth and decay in reservoirs and mains, gives rise to foul odors and tastes, the separation and collection of ferric hydroxide and the discharge at irregular intervals of foul, red water.

When crenothrix collects in filters the blackened decaying masses in the sand are the nidus for putrefactive bacteria. Because of the threadlike nature of the growth, the sand penetrated is held together so that effective washing is difficult. Once a bed has been penetrated progress through underlying gravel and underdrains is rapid; the conidia are capable of beginning new growth wherever conditions are favorable. In one clear water reservoir decaying crenothrix formed a bottom sludge wherein chirnonmus larvae found comfortable lodgment.

As will appear below, the iron demand of the organism is not fixed for all waters; its variations may be occasioned by the reactions of other bacteria in making available the necessary food stuffs. A prolific growth has occurred in one water carrying but 0.3 parts of iron.

The degree of reduction in iron content possible with aeration and filtration through sand varies with the amount and kind of organic matter present. The residual iron in a filter effluent freed from crenothrix is not necessarily such that crenothrix cannot thrive therein; it is rather true that crenothrix does not pass the filters. Yet in one case cited below, in mains already inoculated, fresh growth did not occur although the water contained 0.9 and 1.10 parts or iron per million.

The suggestion is pertinent that the organic food stuff at hand may not have been directly available to crenothrix until transformed by other bacteria. It is possible also that the failure of workers to repeat the culture of crenothrix in the laboratory reported by others is accounted for by symbiotic action in the successful cases and its absence in the unsuccessful.

Rationelle of Treatment

The treatment of iron-bearing waters in which crenothrix occurs has been greatly affected by the notion of the relation of the two factors—iron and the life processes of the organism.

It is stated in Whipple's resume (Microscopy of Drinking Water p. 249) that crenothrix thrives in water containing iron, rich in carbon dioxide, low in dissolved oxygen and high in organic matter. The last factor is to be associated with albuminoid, ammonia, organic nitrogen, color and oxygen requirement. Whether free ammonia is a food stuff or a life product of crenothrix and attendant bacteria in such waters is undecided.

Elimination of crenothrix according to this conception would involve one or more of these four factors: iron removal, addition of oxygen, CO_2 removal, removal of organic matter and possibly ammonia.

Lime Treatment

At Freeport, Illinois, in the fall of 1895 the water supply derived from wells in drift along the river bottom suddenly acquired a bad taste and odor, which could not be accounted for in the ordinary way. Crenothrix was found in the mains. It was believed to require about 0.3 p.p.m. iron for its growth and methods were experimented with to reduce the iron content. An experimental filter was put in operation, using lime. It developed that a reduction of the iron content from an average of 0.796 to 0.045 p.p.m. could be effected and the carbon dioxide from 21.4 to 0 p.p.m. by the action of lime.

A filter plant was constructed in 1903 and put in service October 13; the iron content was reduced in the test run to 0.04 p.p.m.; the CO_2 was entirely removed and the water softened 13 to 15 per cent. During the six months following the completion of the plant, these results were continuously maintained, and the old growth removed from the lines by flushing. (Proc. Am. W. W. Assoc., 1904.)

It is impossible to say what changes were made in the amount of organic matter in this process; whether it was much or little affected by this treatment: but it is probable that it was largely eliminated along with CO_2 and Fe by the use of lime.

The removal of carbon dioxide can be accomplished by aeration, which also aids in precipitating a considerable proportion of the iron content. Aeration followed by filtration was the procedure rationally growing out of the early knowledge of crenothrix. That this process also reduced the organic content of such waters is probable; but the extent of the reduction would vary with the amount of organic coloring matter.

Aeration and Filtration

Early treatment in Berlin (1887) and in Rotterdam (1887) was by aeration and filtration.

A later application of this method to crenothrix and iron removal at Superior, Wis., developed the fact (Proc. Am. W. W. Assoc. 1909, 250) that with aeration, crenothrix was eliminated by slow sand filters, and did not reappear in effluents containing .90 to 1.10 parts iron per million gallons with a color of 25 to 35. Without aeration, filtration through sand eliminated crenothrix; reduced the iron content to about 0.8 parts and the

color to 23 parts; but there followed such a pronounced clogging by the increased precipitate of sticky ferric hydroxide that the capacity of the filters was insufficient to handle the quantity of water required.

In this case the two-fold character of the problem is plain: crenothrix removal by sand filters was simple; iron removal or reduction was considered as a separate matter to be independently treated. Carbon dioxide reduction was finally neglected: crenothrix was filtered out, with the readily precipitated iron, and the effluent diluted to permissible color with iron free water from other sources.

Here again it is presumable that bacterial changes occurring within the Schmutzdecke and the sand brought about a change in the organic matter, unfavorable to the later growth of crenothrix in the previously infected mains.

Iron Removal by Crenothrix Growing in Filters

From experimental work by Professor A. N. Talbott at Urbana in 1910-12 the conclusion was reached that good results could be obtained in a water containing no dissolved oxygen; 40 ppm CO_2; 2 ppm Fe; and 2 ppm NH_4, by partial aeration; reducing but not altogether eliminating CO_2 and introducing 4 to 5 ppm. dissolved oxygen (50 per cent. of saturation), followed by filtration through coarse (torpedo) sand passing 8-mesh and stopped on 12-mesh. This sand (effective size .76 mm. and uniformity coefficient of 3) upon which and into which crenothrix grew, removed all but 0.3 ppm iron for some months. Washing with an upward velocity of 1 foot in 50 seconds dislodged most of the visible filaments of the organism; passing the coarse sand through a centrifugal pump at six month intervals was recommended to insure continuously good results. (Proc. Ill. State Water Supply Assoc. 1911-12-13.)

In this instance use seems to have been made of the organism itself with its allies as an iron removing agency, assisting by infiltration of the older sheaths with ferric hydroxide, the action of the sand grains and their accumulated slime coating in absorbing and retaining the dissolved and precipitated iron.

Although these good results were attained for a period, the penetration of crenothrix into and through the sand, fine gravel, strainers, and underdrains was eventually complete, probably because of less perfect washing than was contemplated by the designer of the plant.

While the reduction of iron to 0.3 ppm or less continued, crenothrix grew abundantly in the clear water basin, in mains, and in service pipes, indicating that oxidation to 50 per cent. saturation did not deter growth of crenothrix or the attendant bacteria of putrefaction. Furthermore it is true that the iron demand of crenothrix is much lower than was formerly assumed. Possibly iron is not essential to crenothrix growth as Ellis and Molisch have claimed.

Germicides Copper Sulphate

Passing from these attacks on the crenothrix problem by removal of what were thought to be its essential food stuffs, we now consider the direct attack on the organism with germicides.

Since 1904 copper sulphate has been frequently used as an algicide. In his latest publication on the subject, Kellerman (8th Int. Cong. Applied Chem. vol. 26 p. 241) confirming his previous experience gives the amount of copper sulphate necessary to destroy crenothrix as 0.3 ppm.

This algicide was applied to the Champaign-Urbana water by Mr. Edman Greenfield some time since. He reported that the high bicarbonate of this water prevented solution of the copper salt and materially lessened its germicidal effect. The experiment was carried no further.

Chloramine Experiments

Considering crenothrix as one of the bacteria subject to the action of germicides, some experiments were undertaken late in 1917, using chloramine, which are described in a paper to appear in the next number of the Journal of the American Water Works Association.

It is sufficient to state here that in laboratory tests it was shown that 0.5 parts per million or 4.17 lbs. of available chlorine per million gallons prevented growth in iron-bearing crenothrix laden water from the university well at Urbana. Samples so treated developed neither taste nor odor during six months' storage although control samples untreated and treated with 1 part per million of available chlorine in bleaching powder gave an abundant growth and thereafter the characteristic taste and odor attributable to this organism.

Without preliminary aeration or iron removal, crenothrix was killed by chloramine and its detritus suffered no decay. The destruction worked by chloramine included, therefore, both the conidia and growing cells of crenothrix and the attendant bacteria responsible, by their activity upon dead detritus, for the putrefactive changes productive of odors and taste in the afflicted waters.

This is of interest as showing the relief offered by such treatment from immediate and remote troubles caused by crenothrix. The attack through the agency of germicides gave promise of simplifying the dual problem of crenothrix-iron removal, safely eliminating crenothrix without embarrassing iron removal, all the while insuring against foul odor and taste. Discussion of the germicidal action of chloramine will be found in the published paper.

It was proposed to apply it at the Champaign-Urbana iron removal plant, but the war demand for both bleach and ammonia was pressing and deliveries were uncertain.

Chlorine Treatment

In February, 1918, the writer recommended to Mr. Amsbary, manager of the Champaign-Urbana Water Company, whose problem was then acute, that 4.5 lbs. chlorine per million gallons be applied to the well water passing to the filters, using a small emergency solution feed apparatus loaned him for the purpose. From Mr. Amsbary's statement (J. Am. W. W. Assoc. for June 1919) the following is quoted, "The crenothrix growth had possession of the filter beds, rendering them inefficient; the reservoirs were foul with it, requiring frequent cleaning. The distribution system was supporting its proportion. Since pipes were stopping up all around the city, the situation was serious indeed. The use of chlorine, introduced into the raw water as it enters the filter beds, had an immediate effect on the crenothrix, causing it to disappear, and since its use began, we have been free of the pest. The filter beds are easily kept sweet and clean; efficiency 90 per cent. and no growth can be detected in the basins or distribution system. It has been a great relief, as complaints which were numerous before its use, have entirely ceased since chlorine has been used."

Mr. Amsbary's reference in the phrase "efficiency 90 per cent" is to the per cent of iron removal from 2 parts per million in the raw water to about 0.1 ppm. in the filtered effluent, which is rather better than the average of earlier results here.

The filter beds which are supplied with fine sand show a reddish film when drawn down, but filaments of the organism formerly so persistent are not found. This seems to indicate that chlorine treatment is efficient in preventing growth of this and its attendant bacteria. Upon scraping away the top ¾ inch of fine sand, there was found fresh, uncolored, unmatted sand, indicating that the iron removel was occurring at the surface only.

Before chlorine treatment was begun, all filters were washed twice daily, and the wash water returned to the receiving chamber after coagulation with two grains alumina sulphate per gallon and sedimentation in a 90,000 gal. reservoir from which all but 0.8 per cent. was recovered through a floating suction. The organic matter in this recovered wash water had putrefied in the receiving chamber and had furnished a nidus for tubificid worms and other foul bottom organisms; this situation made all the more difficult the problem of furnishing a satisfying supply. The accumulation from the receiving chamber was removed shortly before chlorination was begun. (J. Am. W. W. Assoc. 2, (1915) 393.) Bacillus coli was always present.

The filter beds are now washed once in 24 hours; the wash water is still coagulated, settled and recovered through a floating suction; but the worst effects of this questionable practice have disappeared. Bacillus coli is absent.

One of the four filter beds is supplied with fine sand supported on adequate gravel; one has good sand directly on the strainers, through some one's inadvertence; the other two have their original equipment of 30 ins. of torpedo sand on 8 ins. of ¼ to ½ in. gravel.

That the germicide applied to such filters and under these conditions has sufficed to free them from old growth and infection and keep them sweet is gratifying. It is hoped that easier labor conditions may soon permit the manager to complete the equipment of the filters with sand and gravel in accordance with the recommendations made in 1917.

That the defective filters with chlorine have given an unimpared iron removal for more than a year augurs well for the safe working with an even smaller chlorine charge of the better ones, which will have but this one function to perform, namely, iron removal.

Summary

Filtration of water supplies infected with crenothrix is accomplished by removal of the organic matter which is probably the essential food-stuff of the organism. Iron removal is probably incidental; carbon dioxide removal may be either partial or total; both are believed to be non-essential to the life and growth of crenothrix. The destruction of crenothrix and accompanying putrefactive bacteria by the germicidal action of chloramine or chlorine before filtration facilitates subsequent iron removal, and insures the supply thus treated against subsequent development and putrefaction of crenothrix.

A practical test through a period of more than a year has shown 4.5 lbs. chlorine per 1,000,000 gals. of applied water effective in clearing a seriously infected system of filters, reservoirs, mains and service pipes of all accumulations, rendering the water free from taste and odor and color. The iron content is reduced to 0.1 part per 1,000,000.

Acknowledgment

The foregoing paper was presented at the recent annual convention of the Indiana Sanitary and Water Supply Association.

Why Materials of Construction Should Be Tested Prior to Their Use

By Emmanuel Mavant, Concrete Expert with Milton Hersey Co., Ltd., Consulting, Inspecting and Testing Engineers and Chemists, Montreal and Winnipeg, Canada.

One often wonders why it is that so many engineers and architects seem averse to having their building and structural materials inspected and tested before accepting them for use in their work. Too often this is omitted during the construction of high priced dams, bridges, breakwaters, buildings, etc., where the professional reputation of the engineer or architect, the capital of the investor, and, quite frequently, the lives of many people are at stake.

Is it through ignorance? Is it through jealousy and selfishness; not wanting any other engineer or chemist to share the credit for the appearance or assured safety or the structure? Or is it through a mistaken economic point of view? We will review these points one by one.

Some consider testing unnecessary

Is it through ignorance? I may answer that in quite a few cases it is. Engineers of high standing have deliberately claimed to me that it was not necessary to test anything; using as an argument that cement was standard, that any experienced man could tell good sand at sight, and that, as far as stone was concerned, limestone was limestone and that was all there was to it.

These men start the work without knowing the quality of the materials they are using; and, too frequently, their structures fail. If it is concrete, the mass crumbles, disintegrates, cracks, or otherwise goes to pieces, and the average person who sees it concludes that, after all, concrete is a poor investment.

Why Cement Should be Tested

Let us review the arguments of these engineers. They claim that cement is standard. I say it is not; though I know the cement manufacturers, especially the larger ones, do all in their power to have the cement not only up to specifications, but as nearly perfect as possible. But the chemist and superintendent can not be all over the works at once; and, for that reason, there is always a possibility, though it may be remote, of the cement coming out too fresh, too high in sulphuric anhydride, or in magnesia, or too low in specific gravity.

Quick Setting Cement

These defects, which can not be found without having the cement tested, will cause many different troubles in concrete work. For instance, one defect will cause the cement to set too quickly; that is, it will take its initial and sometimes its full set before being placed on the job, while the men are mixing it. In this case there will be no cementitious qualities between the different lumps of concrete as it breaks up when being deposited, and so many stones covered with mud might just as well be thrown into the forms; the results would be as good.

Slow Setting Cement

On the other hand, another defect might cause the concrete to set too slowly. This naturally retards the work, because the forms can not be taken off as quickly as planned. If the risk is taken and the forms removed, there is a great possibility of the structure failing. If slow setting cement is used in the winter time and freezes before it sets, the concrete will soon disintegrate. Even if it should not totally collapse, it will be a constant cause of expense for repairs and an ever-present eye-sore.

I had occasion, some time ago, to condemn 18 cars of cement containing over 16,000 bags and amounting to over $11,000 in value. These 18 cars, which had been purchased by two of our largest Canadian manufacturing firms, were condemned for the reason that the setting took place in from 8 to 20 minutes. It should take at least one hour as determined by the Gilmore needle. Had not that cement been tested, it would naturally have been used, and, without a doubt the work would have failed because of the concrete setting before being placed.

Deterioration During Storage

Outside of this particular case, I have had occasion to condemn cement quite a few times in different parts of the country. In the majority of cases, the cement manufacturer was not to blame for these failures in cement, but either the railway company or the contractor was responsible. Cement is often stored in unsuitable sheds where dampness and rain injure it. Many of us have seen bags that were set as hard as rock taken out of temporary storage sheds. In such an instance, while only certain bags may be unusable, many others, and frequently a very large quantity, have been affected to such an extent that they should not be used.

Another instance came to my attention last summer. An electric power development company situated in the Province of Quebec, were about to raise their dam. The cement was purchased and stored beside the falls in an enclosure with no front. After this was filled with cement, a few boards were put up to protect the cement from the spray of the falls, but cracks ranging from 1 to 10 ins. were in evidence. The result was that the spray reached many of these bags of cement, making some of them so hard they had to be broken up with shovels before using. I drew the attention of the superintendent to this fact, but his answer was that the cement was first class.

It stands to reason that had this cement been tested before using it would certainly have been condemned, as chemical action had already taken place, rendering it of little value. This is but one of the many cases where the cement company was not to blame, and similar instances occur almost daily; but, whether the manufacturer or the contractor is responsible if the cement is not tested, and the work supervised by an experienced concrete inspector, the investor is likely to suffer.

Why Sand is Tested

Now let us go into the sand question. It is claimed that any engineer or experienced man can tell good sand at a glance. That is impossible. He may be able to tell that it is too fine, if it is very much too fine, or too dirty, if it is very much too dirty; but, beyond that, engineers or experienced men can not tell at sight whether this sand or that is good and reliable for strong and dense concrete work.

Sand Lacks Uniformity

All sand contains more or less silt or dirt. The reason for this is that it is composed of small particles of broken rock, of different sizes and compositions, coming from different parts. These particles have been washed away or transported from their different sites at different times and settled in layers of different thicknesses in what is now a workable sand bank or deposit. Therefore, there is no guarantee or even likelihood of uniformity, and one carload of sand may be first class and the next of very poor grade for concrete work.

Also, the dirt and silt, which is very often injurious to sand for concrete purposes, are bound to be present in some parts of the sand bank; because the small particles of rock that are washed towards the bank will naturally carry with them more or less of this fine material.

The above shows conclusively that, in order to be sure of good results, the sand should be tested; not only once, but continually while the work is in progress.

Gradation of Sizes

Besides the avoidance of injurous silt, there is the size or grading of the sand to be considered. It should be well graded, having a certain proportion retained on each sieve from say the eighty mesh to the one-quarter in. sieve. If all the sand grains are of nearly the same size, the voids will be too great, and, unless an additional amount of cement is used, the voids will not be filled. If too fine, the concrete will not be of the required strength. The reason for having sand well-graded is so that the fine particles will fill the voids of the coarser particles, thus reducing them to a minimum.

In order properly to proportion a concrete mixture, it is necessary to determine the voids; for, without this information, the engineers are working blindly and probably wastefully. Where they are figuring on having a good dense concrete for a reservoir, oil tank or foundation, the result is likely to be different and if the water goes through the wall concrete once more gets a black eye.

Injurious Chemicals in Sand

Another very bad fault in some sands, which can not be determined without testing, is that they contain injurious chemicals. Sometimes the drainage from some industrial plant such as a chemical works, soap factory or tannery, though located several miles away, will contaminate a sand supply, rendering it unfit for use in making concrete. As a rule, such contamination is discovered by making 3 to 1 briquettes with the sand under consideration and also with standard sand. A comparison of the results will soon tell whether or not there are injurious chemicals present.

Some years ago, I had occasion to deal with a very interesting case of the above type. A company decided to build a concrete laundry building in Eastern Ontario on the site where an old stable had been standing for years. They tore down the old building; and, in excavating for the cellar of the new, ran across such nice looking sand that they decided to use it in the concrete mixture for the new structure. They had no end of trouble. The concrete would not set, and the walls fell in.

In carrying out an investigation, it was found that briquettes made of this sand would crumble in the hand after seven days setting. These briquettes were so disintegrated that they could not even be put in the machine to test. An analysis was made, and we found that the sand was saturated with ammonia which had percolated through from the horse manure.

As a result of this investigation, the sand had to be taken away from the site of the work, the old concrete thrown out, forms rebuilt, new sand purchased, and the work reconstructed. All this delayed the work, cost money for material and labor to replace that wasted, and inconvenienced the owners. A sensible program of testing would have prevented any of this trouble.

Poor Sand Responsible for Most Concrete Failures

I would venture to say that three-quarters of the failures in concrete are due to poor sand; and then some engineers will not hesitate to state that it is unnecessary to have sand tested.

As far as stone is concerned, the same argument holds as in the case of sand. In order to regulate the mixing of concrete, the voids must be determined; and, in order to get good results, the stone must be clean, strong, well shaped, and well graded.

It might well be stated that the best argument for the general inspection and testing of all building and structural materials is that every large corporation such as the Canadian Pacific, the Grand Trunk, the Canadian National Railways, the Montreal Tramways, the Montreal Light, Heat and Power Company, the Harbor Commissioners of Montreal, Toronto, Hamilton, London, Peterborough, the departments of the government, provinces, states, the counties and municipalities that are at all progressive, and large private concerns too numerous to mention, all have their materials thoroughly tested before using. The sooner other engineers and architects make up their minds to have testing and construction supervised by experienced men, the sooner eyesores, failures and constant repairs to concrete work will stop.

Some Engineers Do Not Like to Share Credit

I happened to interview the City Engineer of one of the larger cities of Canada on the subject of supervising concrete construction and the testing of the materials for it. After a long conversation, he agreed that the construction materials should be tested, but turned and said: "Where do we come in? You will be the party doing the work, and getting the credit. The Municipal Council will say, 'These engineers of ours are of no use if they must get their materials tested and work supervised.' If we were to do that, we might find ourselves out of a job."

Whether it is the effect of the above policy or not it is hard to say, but this particular city has had constant trouble and very heavy expenditures for replacing defective work. They erected a Fat Stock Show building, and the whole thing collapsed. Their water main cracked, and, as it was a suction system, sewage polluted water was sucked into the mains and contaminated the drinking water. This caused a typhoid fever epidemic that carried off in the neighborhood of a thousand people, and forced the city to open emergency hospitals that it had to furnish and provide with doctors, nurses and orderlies. The boiler in one of their municipal buildings exploded, killing one man, injuring others, and wrecked the building. A pavement about 25 city blocks in length took on the form of a corrugated road, and had to be relaid a few years after it was first put down.

It goes without saying that all this trouble cost the city many thousands of dollars which might, and very likely would have been avoided had all the materials used in these constructions been tested and the work supervised by some one particularly familiar with each type of construction. Any possible loss of prestige to any engineer or architect through

the employment of outside specialized inspection and testing service could not conceivably injure him as much as one failure such as we have mentioned. In fact, after the failure, some one will ask why he did not have knowledge enough to understand that he needed such specialized service. The family physician does not try to operate on his patient's heart; the City Engineer should not think it necessary to pretend that he knows it all either, and the same applies to the outside engineer or architect. Specialists usually pretend to know but one thing, but to know that one thing uncommonly well.

Mistaken Idea of Economy

A good many engineers will say that this or that work is not of sufficient importance, or will not be seen, so spending money on tests for it is waste of money. This is very unwise economy, in fact, not economy at all. It is a case of saving the pennies to throw away the dollars; for, when the construction materials are tested and accepted by specialists, and the work supervised by them, the engineer or architect is practically relieved of all responsibility except that of having selected competent specialists to do the work. He can not do all this himself. He must hire some one; so why not those particularly competent to take care of the particular matter for him?

Besides, if his plans and specifications are correct, he is sure there will be no unwarranted expense for repairs, and the structure will be there to stay as a monument to his name and a foundation for his future reputation in the engineering profession.

The engineers and architects who are foremost in their profession would not consider for a moment using materials of construction without full inspection and testing as the work progressed; therefore, why should men who have not yet reached the pinnacle of professional success risk failures that might forever preclude their arrival?

New Type of Portable Conveyor for Handling Loose Bulk Materials

A new type of portable conveyor, which cuts the labor of feeding one-half, is shown in the accompanying illustrations. The most distinctive feature of this machine, called the scoop conveyor, is the scoop on the feeding end which can be pushed into or completely buried in the material to be conveyed. This makes it possible to simply scrape the material onto the carrying belt instead of lifting it up by shovelfuls into the feeding hoppers as with ordinary conveyors.

scoop conveyor hold the material together, giving the whole width of the belt carrying effectiveness. It is due to the skirt plates, also, that a scoop conveyor 24 ft. long will convey material as high as a 30-ft. troughed belt. The resultant saving in belt expense is considerable, as two new 12-in. by 24-ft. scoop conveyor belts can be purchased for the price of one 20-in. by 30-ft. troughed conveyor belt.

While the scoop conveyor has been on the market only a short time, the manufacturers claim that there are now over 1,000 in use and that they are receiving nearly 50 percent repeat orders.

The money savings resulting from the use of a scoop conveyor are due, first, to the saving in labor; second, to the speed at which material is conveyed. In comparison with handling material by hand, one or two men with a scoop conveyor will do the same work as from four to twelve men, depending upon conditions. The scoop conveyor will load trucks in one-fourth to one-sixth the time required by men shoveling. It often enables one truck to do the work of two and of getting two days' work done in one day.

Storage capacity is another factor of saving attributed to this machine, as it increases the available capacity of a shed or yard space by enabling the men to pile higher.

The carrying capacity of the scoop conveyor, based on handling coal, is 1 ton per minute, provided a sufficient amount of coal is maintained at the receiving end of the machine. If the storage pile is of sufficient height, one man can easily feed 1 ton in 1½ minutes, or, if the pile is low, he may require from 2 to 4 minutes. Where speed is required two men may be provided for feeding. In unloading hopper bottom cars the machine and one man can remove 1 ton per minute.

Large size coal, coke, crushed stone, etc., fed by one man, require from 3 to 6 minutes for 1 ton or half that time with two men.

The scoop conveyor is used principally for storing, reclaiming and loading bulk material and light articles. There are a number of uses for the machine, in addition, such as elevating material to tanks or platforms in chemical and industrial works, feeding from cars and delivering into fixed conveyors or stoker magazines at power plants, etc. Almost any kind of material can be handled, such as coal of all kinds, ashes, sand, earth, crushed stone, blast furnace slag, ore, fertilizer, salt, chemicals, grain, bags and light packages.

The scoop conveyor may be used singly, in tandem or in triplicate, as may be required. The employment of sets of two or more allows for an increase in height of the storage pile or conveying distance. The machine is made in three sizes, 14 ft.,

VIEWS ILLUSTRATING USES OF THE PORTABLE SCOOP CONVEYOR.

Another special feature of this machine is the construction of the sides, or skirt plates, as they are called. These form a trough which enables a 12-in. belt to equal in carrying capacity a 20-in. ordinary troughed belt. This is readily understood when one remembers that on a troughed belt the material is carried in the center of trough, that on the sides falling into the trough or rolling back, whereas, the side plates on the

20 ft. and 24 ft. On either size the conveying belt may be 12 or 16 ins. wide. The machines are furnished with either electric motor or gasoline engine drive. This conveyor is manufactured by the Portable Machinery Co., of Passaic, N. J., who have just published a folder entitled, "Over 1,000 Scoop Conveyors," which illustrates all the uses of this piece of equipment.

Land Drainage Procedure in Iowa

By G. D. Hart, C. E., Consulting Engineer, Bancroft, Iowa

Throughout the states of Illinois, Iowa, the Dakotas, Minnesota and Wisconsin, as well as several of the southern states, countless miles of underground drains have been constructed. It is estimated that the state of Iowa will have used enough drain tile within the next ten years to traverse the circumference of the earth five times.

The size of drainage tile range all the way from 4 ins. in diameter to 6 ft. in diameter, although systems laid in the early history of drainage contained tile as small as 1 in. in diameter. Some of these are reported to be still doing service—after the manner of their kind.

The history of underground drainage probably began back in the years preceding 1620, when drain tile were discovered in the convent garden at Mubeuge, in northern France. Later the invention of "land pipes" was recorded in England, from whence they were finally brought to the United States. One John Johnston, of Geneva, N. Y., is credited with the honor of being the "Father of Tile Drainage in America." Between the years of 1835 and 1851 he placed some 16 miles of tile on his farm with gratifying results. From thence the drainage movement pressed westward, gaining in favor and magnitude as it progressed.

The magnitude of the tile-drainage industry may be perceived from the fact that in the state of Iowa alone there are 7,100,000 acres of land that require drainage to make it productive. The estimated cost of draining this acreage is $400,000,000.

From the viewpoint of strict engineering, drainage engineering is not overly spectacular. In fact, we find little or no mention of that branch of engineering in the press.

However, the design of an efficient drainage system is far from a scientific guess. To give ample service a drainage system must have sufficient capacity to carry the rainfall away with such rapidity that water will not stand over the roots of vegetation for a greater period than 24 consecutive hours.

The amount of water to be carried by the tile is affected by the following factors, viz.: amount of rainfall, frequency of rainfall, area of watershed; character of the land, flat or rolling; porosity of the soil, etc. In the area covered by this article it is customary to make the capacity of the tile sufficient to carry from ¼ in. to ½ in. run-off in 24 hours.

The velocity of flow in a system of drain tile may be calculated by any of the formulas for flow of water in channels or pipes, such as the formulas of Prony, DuBaut, Weisbach, Bazin, Chezy, Poncelet, Kutter and others. Certain modifications must be made, however, due to the following facts: A tile system is composed of short sections from 1 to 3 ft. in length, whereas pipes of iron or wood are usually continuous; drain pipes are usually rougher than iron or wood pipes; water enters a drain system at nearly every joint; laterals of greater gradient than the main exert additional head thereon, and the water in the soil above the tile adds a certain amount of pressure or head.

The formula in general use among drainage engineers is known as C. G. Elliott's modification of Poncetel's formula. Elliott's modification gives the formula the following appearance:

$$V = 48 \sqrt{\frac{d\,(h + \frac{1}{24})}{l + 54\,d}}$$

Where V equals velocity of flow in feet per second; d equals diameter of tile in feet; h equals head, or difference in elevation between outlet and upper end in feet; k equals cover on tile at some point, near head of same, where surface water will collect; l equals length of drain in feet. Quantity of discharge is of course equal to the area of tile multiplied by the velocity of discharge. Experience, however, has convinced the writer

LAYING 22 IN. DRAIN TILE IN 21 FT. CUT. AT THIS DEPTH TILE ARE LAID IN CONCRETE CRADLES AS A SAFEGUARD AGAINST CRUSHING.

that where the available grade for a tile system is 0.50 ft. or less per 100 ft. station—the cross-sectional area of system should be increased somewhat.

For tile larger than 16 in., inside diameter, the constant (48) should be increased as follows: 18 in. to 53; 24 in. to 57; 30 in. to 60; 36 in. to 62; 42 in. to 64; 48 in. to 66; 60 in. to 68.

The laying of drain tile is not materially different from the laying of sewer systems except that the joints are intended to admit water to the system. Various mechanical excavators

VIEWS OF HEAVY LAND DRAINAGE OPERATIONS IN IOWA.
Floating Dredge Excavating Open Drainage Channel.—The Open Ditch; Machine Just Ahead which accounts for the High Water.

have been placed on the market, but have not met with a great degree of success, due chiefly to the fact that the necessarily heavy and ponderous machinery is difficult to operate in wet, swampy ground. The best equipment for properly laying drainage tile—according to our local wit—is "a good foreman, a good engineer, a gang of Norwegians with weak minds and strong backs, and an inspector whose only friend is his wife."

Some of the essential points to be noted in laying a drainage system are: Good close joints—joints that will permit the entrance of water, but exclude sand and soil; a fairly even grade—a rough grade cuts down the discharge area and adds an element of roughness; well-cemented junctions—the writer prefers field junctions to factory junctions, if the former are

VIEW SHOWING OUTFIT USED BY LAND DRAINAGE FIELD ENGINEERING PARTY.

carefully cemented; slow and regular curves rather than sharp angles; and, above all, sufficient depth—at least 4 ft. is good practice for this local district.

And now just a word as to the value of drainage. Within the writer's knowledge the highest local cost for draining a 40-acre tract will be about $100 per acre (this is an exceptionally wet tract). The value of this land when drained will be about $150 per acre, making the total valuation $250 per acre. Assuming that this tract will average 40 bushels of corn per season at $1 per bushel, the investment will yield $40 per season, or a profit of $25 per acre. This means a profit of at least 10 percent on the investment.

Land in this locality has risen in value from $30 to $150 per acre within the past twelve years, due chiefly to the fact that drainage has increased the acreage available for tillage by at least one-third.

New Pennsylvania Highway Commissioner Will Not Tolerate the Ripping Open of New Pavements

Lewis S. Sadler, recently appointed state highway commissioner of Pennsylvania, has declared that there will be absolutely no deviation from the rule that no permanent paving will be put down in boroughs of Pennsylvania, so far as the state highway department is concerned, until every pipe or sewer connection is made on the thoroughfare to be improved. This announcement is in line with Governor Sproul's determination that there shall be no waste of state highway funds.

"Before we proceed with the construction of permanent thoroughfares through boroughs of Pennsylvania," said Commissioner Sadler, "we will have agreements with the borough authorities which will prevent the ripping of pavements. And we shall insist that these agreements be lived up to. For not less than *five years* after completion the pavement may not be disturbed, unless in case of extraordinary emergency. We do not propose to waste money. I can conceive of no reason why the boroughs themselves, the corporations and private property owners cannot lay their sewers and mains of various sorts in anticipation of paving. I know of no reason why old mains cannot be removed, if necessary.

"In the case of vacant lots, where construction begins after the paving is laid, will the rule regarding sewers and piping be enforced?" the Highway Commissioner was asked.

"Most assuredly," was the reply. "Owners of properties should lay all necessary piping before we begin paving. They must anticipate construction.

"Many roadways in Pennsylvania which otherwise would have lasted for a great many years have been ruined in a comparatively short time because they were ripped up for the laying of piping. I know of instances where within a few months after completion of a long stretch of brick paving a public service corporation ripped the street for a distance of half a mile to put down a water main. This could have been avoided. It is not possible effectively to patch highways of the rigid type after they have once been cut through. In spite of all precautions taken it is never possible to get the same uniformity in the patch as was had in the original job. Lack of uniformity is one of the primary causes of early deterioration. That is demonstrated in the case of bituminous types where irregularities hold moisture and other foreign materials and cause disintegration of the paving. No element has as detrimental an effect on bituminous paving as water; and it is not possible to keep out water where a patch has been made. The surface must be kept true in order to assure a perfect roadway. In paving of other than bituminous kinds there is always a line of cleavage, as a result of which water creeps in and in times of freezing and thawing displaces the surface.

"For these reasons—because we will save the commonwealth many hundreds of thousands of dollars, we will not lay a foot of paving in any borough of Pennsylvania until every single water and sewer and gas connection, or underground connection of any other kind, has been completed.

"I mention this matter now because the spring of the year is coming and it will be possible for municipalities, public service corporations and individuals to do whatever street ripping is necessary. Once our paving is down it will not be disturbed."

Design of Concrete Sidewalks and Concrete Curb and Gutter at Street Intersections

By W. Robert Paige, Civil and Consulting Engineer, Terre Haute, Ind.

In 1917 the writer had charge of developing a large tract of ground belonging to the Deming Land Company of Terre Haute, Ind., into improved city property. The property lays within the city limits of Terre Haute, and is surrounded on two sides (the west and the north) by well developed portions of the city. Along the north side of the track, for a half mile, the Old National Road (now Wabash Avenue through Terre Haute) from Cumberland, Md., to St. Louis, Mo., runs south 78 degrees and 14 minutes west. As the intersecting streets were laid out due north and south, the lines of the walks and curbs intersect at an angle of 78 degrees and 14 minutes on the west side, and 101 degrees and 46 minutes on the east side.

The roadway of Wabash Avenue had been curbed with limestone curbing, and paved with brick. Street intersections from the north had been extended from the south curb to the south property line and paved. As these intersections did not meet the new streets in the subdivision, it was necessary to remove them and make the improvements conform to the new conditions. All other street intersections were practically at right angles. The roadway of the street along the west side of the subdivision had previously been curbed, but fortunately no openings had been left for street and alley extension

Among the many interesting problems this improvement developed was the construction of concrete sidewalks and curb and gutter at street intersections. The tract being practically free from any improvements afforded an opportunity to adopt different plans from the stereotyped ones used by the city. For example, about 26 years ago the city adopted a standard curve at street and alley curb intersections of 6 ft. radius for the former, and 4 ft. radius for the latter. These standards have been, and still are, rigidly adhered to regardless of the great change in traffic conditions.

The Deming Land Company adopted a minimum curvature at street intersections of 15 ft. radius, and a maximum curvature of 40 ft. radius, and a curvature at all alley intersections of 10 ft. radius. These plans have been recently approved by the city.

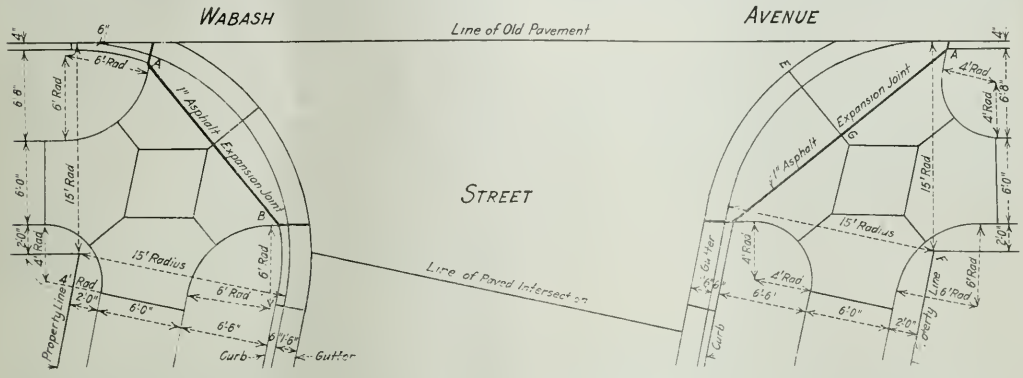


FIG. 1—PLAN SHOWING SIDEWALK AND CONCRETE CURB AND GUTTER TREATMENT AT STREET INTERSECTION.

Figure 1 shows a plan of an intersection of a north and south street with Wabash Avenue. The special feature is the construction of the curb and gutter at its intersection with the concrete walks. The inside lines of the concrete walks from opposite directions extended, intersect the curb lines at "A" and 'B." A straight line connecting these two points form the back side of the curb and gutter, the circular line of the back side of the curbing being eliminated in this section. This gives the appearance of a broad step rather than a curbing, which effect is very pleasing. An asphalt expansion joint 1 in. in thickness and 4¾ ins. in width is placed along the line A-B which separates the walk from the curb and gutter. A joint also extends through the curb and gutter at points "A" and "B".

Figure 2 shows the cross-section of the curb and gutter and the sidewalk through the diagonal E-F. It will be noticed that the thickness of the curbing along the line A-B is the same as at the curb line. The theory for this construction is that the resultant from the expansion forces of the two walks coming together from opposite directions is practically at right angles to the line A-B, and is greatest at "G", gradually diminishing to the points "A" and "B." We have, therefore, the greatest mass of concrete at E-G to resist the greatest pressure, and the mass diminishing as the forces diminish towards A-B.

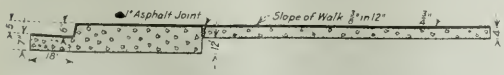


FIG. 2—SECTION THROUGH E-F OF FIGURE 1.

The walks are also cut through along the lines shown on the plan. The diamond at the center is formed by extending parallel to the inside and outside lines of the walks, lines equidistant from the same. The walks are squared off at the end of the curves as shown on the plan, after which they are cut in regular blocks of 6 ft. in length.

Another special feature was the paving of the intersections. Instead of paving to the south property line of Wabash Avenue, as was the custom of the city, we started at a line C-D (Fig. 1), at right angles to the curb lines of the intersecting street, the point "C" being at the intersection of the gutter line with the south property line of Wabash Avenue.

The pavement was of the monolithic type, the brick being laid at right angles to the intersecting streets.

The pavement was started along the line C-D, and closed up along the line of the old pavement. This required just one line of bats along the old line of pavement, and leaves the line of the paved intersection in correct form for future extension when desired.

Figure 3 shows one of the four corners of the intersection of two streets, approximately at right angles with each other.

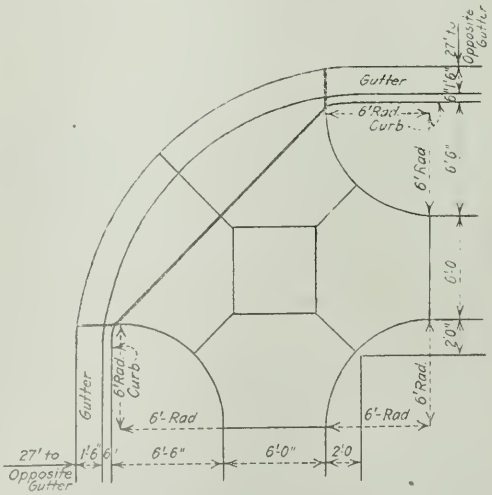


FIG. 3—TREATMENT OF ONE OF FOUR CORNERS OF TWO STREETS INTERSECTING ALMOST AT RIGHT ANGLES.

This plan was afterwards slightly modified by changing one of the walks from 6 to 5 ft. in width. This, however, did not materially change the form or appearance of the corners.

The Relation of Highways to Motor Transport Efficiency

By Arthur H. Blanchard, Consulting Highway Engineer, Broadway and 117th St., New York City

The efficient development of highway transportation through the means of the motor truck parcel post service, return load bureaus, intercity freight delivery, rural express and other methods of motor transportation, necessitates the utilization of highways during 365 days of the year and the construction and maintenance of good roads everywhere, said Mr. Blanchard, in addressing the Conference on Modern Methods of Motor Transportation, recently held in New York.

Economic Conditions

The practical development of this program calls for the expenditure of vast sums of money, at least one billion dollars annually. The cost of highways of the future is problematical. An indefinite period will elapse before the wages of labor and the cost of materials will be adjusted to normal conditions. These economic questions constitute a problem which must be given exhaustive consideration. One phase, upon which it is advisable for all to deliberate, is the sources of the unskilled labor so largely used in highway improvement. The world war has materially reduced the available supply in this country and the reconstruction of Europe will prevent the usual additions through the avenue of emigration.

Financing

Today there are in the United States 2,500,000 miles of rural roads, 12 percent of which are classed as improved. A conservative estimate would indicate that not more than one-fourth of 1 percent of the total mileage is suitable for motor truck trunk highway traffic. During 1917 there was appropriated for the improvement of rural roads $300,000,000. This work is under the jurisdiction of the Federal Government, the State Highway Departments, over 3,000 counties in the various States, and the innumerable townships. The scope of this brief resume will not allow a discussion of the methods of financing highway improvements, but it is advisable strongly to emphasize the indisputable fact that it is reckless financing to construct roadway surfaces, which will have a life of 10 years, with 50-year bonds.

For a National System of Highways

Today there is no national system of highways in the United States comparable to the world renowned national system of France. Indications point, however, to a rapidly developing sentiment and demand for the creation of a system of interstate highways aggregating between 50,000 and 150,000 miles, which shall be constructed and maintained under the supervision and at the expense of the Federal Government. Such systems of highways as we now have are practically developed through the individual or co-operative action of our State, county and township governments, Federal aid constituting a very small percentage of the total amount expended. The development of systems in many parts of the United States is in a chaotic condition, due primarily to lack of foresight and wise administration, local jealousies and ineffective laws.

Educational Work

Efficient and economical highway improvement has been seriously jeopardized in the United States through political interference and the placing of highway work in the hands of laymen who have had no experience in this important technical profession. Unfortunately, the public neither appreciates the character of the duties of highway officials nor does it take proper interest in the expenditure of its funds. The people must be educated with respect to the complex work for which highway officials are held responsible and the waste of public funds directly attributable to having highway work in the hands of laymen. It should be emphasized that the primary objects of the educational campaign advocated are: First, the economical and efficient expenditure of the millions of dollars annually appropriated for highway work, and second, the appointment of members of the highway engineering profession to the innumerable positions of responsibility in public life which demand the combination of administrative ability, honest character, and the technical knowledge, training and experience possessed by qualified engineers.

Standing of European Highway Engineers

As in the case of many public activities, it is practicable in connection with this problem to derive valuable suggestions from practice in foreign countries. A review of their histories indicates that they have passed through the same transition period which we are entering. In France, many years ago, the people and the servants of the people realized the advantages accruing from the establishment of a permanent organization of efficient, well-trained highway engineers, and hence there was created the renowned Department of Roads and Bridges of France. Passing across the English Channel, we find similar conditions in Great Britain.

In order to secure a dollar's worth for every dollar expended, the British public realized that it was necessary to have in control of their public works men trained in a profession directly dealing with every economic and engineering phase of public improvements. It has therefore inaugurated the practice of requiring that applicants for a given municipal or county position shall have attained the grade of membership in the Institution of Civil Engineers of Great Britain commensurate with the responsibility of the work of the particular office. Many leading municipal and county positions require that the applicant shall, first of all, hold the highest grade of membership in the Institution, while positions in small counties, towns and districts require in many cases associate membership.

It would seem desirable in this country that a step along the line of English practice might be taken, and, in the case of positions of highway officials, that there be incorporated in the constitution of a State or the ordinances of a city the stipulation that the applicant shall hold a certain grade of membership in the American Society of Civil Engineers and have had a certain number of years of experience in highway work.

Motor Traffic

The problems confronting the highway engineer of today are entirely different from those which existed 15 years ago. At that time the motor vehicle was not a factor. Today between 5,000,000 and 6,000,000 motor vehicles use our highways, 10 percent of which are motor trucks. Instead of constituting practically 100 percent of the traffic, as in 1903, horse-drawn vehicles at present amount to 5 to 20 percent on highways outside of urban districts.

Types of Roads

With the enormous development of motor truck highway transportation, which this country is to witness in the next five years, many established practices in highway work must be remodeled. It is self-evident that the increased tonnage will call for ideal drainage, strong foundations and roadway surfacings suitable for motor truck traffic. In this connection may be cited the recommendation of the former New York State Department of Efficiency and Economy, in 1915, that all trunk highways should be built with cement-concrete foundations. Dependent upon the amount and character of the traffic to which a trunk highway will be subjected during the life of its surface and other factors influencing its selection, the following types are suitable: Bituminous concrete, cement-concrete, brick and stone block.

Width of Roadway

As of particular interest to the advocates of the develop-

ment of motor truck transportation is the present condition pertaining to the width of pavements on trunk highways. Reviewing the construction of the past few years of the types of pavements heretofore mentioned used on trunk highways, it is found that the widths vary from 12 to 18 ft., with a few instances of greater widths. In this connection it is of value to note that the Highway Committee of the American Society of Civil Engineers recommended several years ago that "where motor truck forms a considerable portion of the total traffic likely to use a highway, the unit width of traffic lines should be considered as 9 or 10 ft., instead of 7 or 8 ft., as heretofore." Furthermore, as far back as 1908, the First International Road Congress, held in Paris, adopted this resolution: "There should be but one roadway for every kind of vehicle, 19 ft. 8 in. wide at least." It is, of course, well known that many of the main county highways of England have an improved surface of from 20 to 22 ft. and that the main trunk highways of France are practically 24 ft. in width. When the rapid development of touring car, motor truck traffic and motor bus routes are given consideration, it is obvious that our important inter and intra-state trunk highways should have roadway width of not less than 20 ft.

Other factors in the construction of highways, which must be given careful consideration during the next few years, are strengthening of highway bridges, grades, location and alignment of highways, adequate guard rails, and uniform highway signs.

Efficient Maintenance

The people of the United States are beginning to appreciate the fact that in order that value is received for the money expended in the construction of highways it is necessary that the highways should be efficiently maintained. Some method must be devised by which the legislatures shall annually appropriate sufficient funds to maintain improved highways properly and economically. Legislature after legislature has followed the procedure of discounting the estimates submitted by highway departments. Hundreds upon hundreds of miles of highways are today improperly maintained, due to a lack of funds. It should be borne in mind that if maintenance is curtailed in one year in a given state to the extent of $500,000, and miles of highways are thereby left unrepaired, the appropriation required in the following year to repair the damage to the highways not maintained may amount to a million dollars.

Uniform Highway Traffic Laws

It is of vital import that uniform highway traffic laws should be placed on our statute books. Such laws must cover the physical factors and the operation of all types of vehicular traffic. Laws will be based on available data and opinions. There are, at present, innumerable investigations which should be made to ascertain facts pertaining to the interrelationship of motor truck traffic and the durability and serviceability of highways. If highway departments do not conduct such investigations, they should be undertaken at once by motor truck interests. If the essential data is not available, naturally traffic laws will be based upon conservative conclusions reached by highway officials and members of our legislative bodies.

Shortage of Road Contractors in South Dakota

To the Editor:

"South Dakota has available for the next two or three years $11,250,000, besides county levies which foot nearly $2,000,000 and auto funds of nearly $1,000,000 for maintenance. So you can see that the people are thoroughly imbued with the good roads idea.

"The legislature which recently finished its session passed a law authorizing a $6,000,000 bond issue, besides giving us over a half million by direct appropriation. We also have a new highway law, which we consider a very flexible law, granting plenty of power to the new commission.

"We are shaping our program for a very busy summer. Our only drawback will be a shortage of contractors to carry on the projects. We can prepare for them with our efficient office and field forces."

Very truly yours,

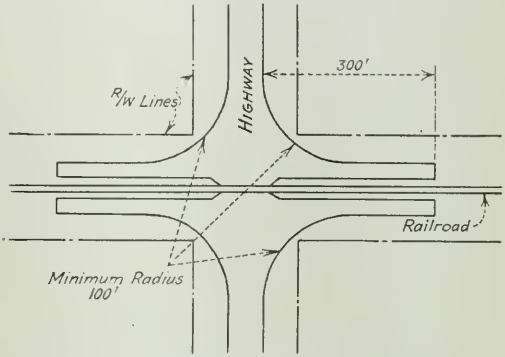
FRANK S. PECK, Highway Engineer,
South Dakota State Highway Department.

Pierre, S. D., March 20, 1919.

Engineering Treatment of Necessary Railroad Grade Crossings

By Rodman Wiley, Commissioner of Public Roads of Kentucky, Frankfort, Ky.

When travel was mostly by steel tired vehicles, the danger at crossings was at a minimum, and naturally the question did not receive, and was not expected to receive, the consideration it does today when most men are endeavoring to save time and make money, and the majority of the travel is by automobile and automobile truck. In order to take care of this new



SKETCH ILLUSTRATING ENGINEERING TREATMENT OF HIGHWAY AND RAILWAY GRADE CROSSING.

method of travel, the highways are now carefully planned, particular care is being taken to see that the proper type of surfacing is used, wide, strong and expensive types of bridges are being built, but the grade crossings are receiving practically no attention.

Highway Rights Ignored

It has been customary for some years when one railroad crossed another railroad company's track for the one desiring the crossing not only to receive permission from its senior but to furnish the necessary frogs and install all interlocking signals. The same is true when interurban lines cross railroad tracks.

We know it is impossible to span a navigable stream with either a highway or railroad bridge without first receiving a permit from the Federal Government. The government specifies the length of span and the height the bridge must be placed above low water; in other words, the government appreciates the fact that neither of the other two systems of transportation should interfere with the safe passage of boats; yet until very recently it was known to be an almost unheard of thing for highway officials to be consulted when a road was to be crossed by either railroad, interurban or street car lines. In many instances such crossings have been made without even installing danger signals.

In the majority of cases crossings are treated the same today as ten years ago, and it appears that the principal cause of the trouble has been the lack of attention not only on the

part of the officials, but by the people, which naturally implies the lack of engineering advice.

Precautions Taken at Grade Crossings

Statistics show that the railroad companies pay out considerable sums of money because of accidents and deaths at grade crossings. Naturally such corporations endeavoring to reduce their expenditures to a minimum, and especially to save *human lives*, have installed all sorts of safety devices, a great many of which are absolutely ignored by the public. We now find stationary electric bells in some cases, swinging electric bells in others, electric lights and finally at the most important places we see gates and watchmen.

Considered from a purely financial standpoint, very few railroad crossings are properly maintained so that a machine is damaged each time it passes over one. Suppose that the damage to a machine amounts to only one cent and that a hundred machines pass that crossing in a day. That means that damage has been done to the extent of one dollar per day or $30 per month, $360 per year, which is the interest on $6,000.

Grade Crossings Are Usually Unavoidable

I take it that necessary grade crossings are made so because of great difficulties which would be encountered in eliminating them. Such things as the topography of the country, rights-of-way trouble, damage to property and, in its final analysis, lack of funds, because certainly the majority of crossings are unnecessary provided the money is available to eliminate them.

It makes no difference what is suggested, there will always be accidents so long as we have grade crossings, and anything that is done is merely an insurance against death or accident and the first question would most naturally be, who should pay the bills? We find that when either a highway or railroad company crosses a river, which is navigable, they pay the bills, and when one railroad company crosses another, the junior company pays the bills; the same is true of interurban lines crossing railroad tracks.

Responsibility for Grade Crossing Accidents

One might naturally think that the railroad grade crossing question should be handled in the same manner. The railroad company, however, being a corporation, is liable for damages and should and perhaps would in most cases be willing to pay part of the cost, even though they might have priority claim at the crossing, but certainly if the people are determined to travel at a greater rate of speed so that their lives are more in danger than they have been in the past when most grade crossings were allowed to come into existence, and especially when human nature and human carelessness enter so much into the proposition, the public should pay some part of the cost. It should be remembered that the people, not the railroads, have changed their method of travel.

No two men behave exactly in the same manner when crossing a railroad track. A few will stop and listen for approaching trains, others will slow up their machines and look hurriedly to the right and left, but the majority will plunge headlong over the track without taking any precautions whatever, and certainly no concern should be penalized for the lack of attention paid to all warnings, especially when the railroad is a necessity and is rightfully allowed to exist under the laws of the country.

The highest courts in many of our states have refused to give judgment against railroad companies because the drivers of automobiles have not exercised reasonable precautions in crossing railroad tracks.

It is a question of human life against money, and I venture to say that very little will ever be done until the public appreciates the value of a human life. All sorts of excuses will be given and accepted because in order properly to protect their own lives and the lives of their fellow men, the people would have to pay a little more taxes.

Engineering Recommendations

Some engineers after carefully studying the question have recommended that the highway on each side of the railroad track should be made straight and level for some distance back of the track. That, of course, is a great precaution, and would tend not only to prevent accidents from collisions with trains but it would also tend to prevent accidents on the highways, as sufficient sight distance would be provided. Others recommend all sorts of electrical devices and interlocking signals to warn men that a train is within a certain distance of the crossing.

All electrical devices, however, are liable to get out of repair, and might not in isolated districts receive attention for many days. In such cases, no warning would be given in the interim, so we cannot depend entirely upon such things.

Because most accidents are due to the speed at which automobiles are driven, there should be a national law preventing any manufacturer under heavy penalty from making any pleasure automobile that can attain a greater speed than 30 miles per hour, and then every driver can keep his car under control.

Relocation

Considerable danger could be removed if a great many of the roads were relocated and that could be done in a great many instances. Where a road parallels a railroad for some distance before crossing, the road should, if possible, be at least 300 ft. from the track and the crossing should, if feasible, be made at right angles to the track. In addition, all obstructions to the view should be removed so that when a man makes the turn preparatory to crossing the track he can see both ways up and down the railroad for some distance.

As an added precaution, it would be well to build a road parallel to the railroad track for a distance of perhaps 300 ft. each side of the main road, and, in all probability, it should be on the railroad company's right-of-way. The surface of the road should be at the same elevation as the top of the rails; in case a man saw he could not clear the track, or in other words that he was caught, he could turn, either to the right or left, off the main highway and run his car parallel to the track and prevent a collision.

Of course such things as electric lights, electric bells, etc., should be used in all cases because they always serve as a good warning.

Specific Recommendations

Important crossings should be well paved, the paving to be level with the top of the rails so as to prevent a man killing his engine on the track; also to save the wear and tear on vehicles.

Less important crossings could be paved with timber, say 2 ins. thick, set on edge, sized so as to make it level with the top of the rails, the timber to be nailed to ties and to each other and all points of contact to be tarred. This would make a rather inexpensive improvement and it is believed the results would be admirable as 2x4s spiked together and tarred have been used very successfully as flooring for bridges in Kentucky.

As a general proposition, it would be well, as has been advocated, to make the road straight and level with the top of the track for a distance of at least 300 ft. each side of the center line of the railroad and to have all obstructions such as brush, high banks, etc., removed so that a man can see both up and down the track when traveling any part of the 600 ft.

Inasmuch as crossings might be divided into several classes according to their hazardous nature and volume of tradic passing over them, it might be well for representatives of the railroad companies in the various states to meet with the proper highway officials, take a census of all crossings and divide them into classes. At the most hazardous or otherwise important crossings from a standpoint of travel, in addition to

doing all that has been said, it might be well to have gates and watchmen.

Sufficient precaution should be taken either in the way of making such changes as have been advocated or else the driver of a vehicle should be required to stop and walk across the track before attempting to drive across.

A street intersection in a busy town might be considered a necessary grade crossing. It is not, of course, in all cases a railroad crossing, but is subjected to a great volume of traffic. We find that soon after the advent of the automobile, the police departments in practically all towns had watchmen stationed at the intersections to take care of the traffic.

An examination of the practice of street car companies and interurban companies in crossing the railroads shows that almost invariably the street cars or the interurban cars are required to stop on one side of the track, the conductor crosses the railroad track and signals the car ahead.

I know that complaints would be made by the autoists because of the time required to stop their machines and walk across the tracks, but when a man attempts a journey in an automobile he is aware of the fact that he will, in all probability, have punctures and blow-outs and he is willing to take his chances in order to save time, and travel when it suits his convenience, and certainly if he is willing to repair two or three punctures in the course of a journey in order to go as he pleases, he should not complain if a few minutes of his time are taken up endeavoring to save his life.

The public should appreciate the fact that no precaution on the part of any railroad company will save a man's life if he is determined to be a fool.

Acknowledgment

The foregoing discussion is the major portion of an address delivered before the annual convention of the American Association of State Highway Officials.

Proper Regulations Governing Private Fire Protection Water Service Lines

By Dow R. Gwinn, President and Manager, The Terre Haute Water Works Co., 634 Cherry St., Terre Haute, Ind.

In considering fire protection, there should be no confusion between that which is furnished by the municipality, known as public fire protection, and that which is for the exclusive use of an individual, or manufacturing concern. In the first case, the pipes and hydrants are on public streets, while in the second case, large pipes are laid into private grounds and buildings to which are connected fire hydrants, automatic sprinklers, and stand pipes.

The manufacturer who desires something more than the public fire protection should, of course, pay for private protection of a special character.

A comparison could be made with the public police protection furnished by the municipality and that of a manufacturer paying for a private watchman or policeman. The municipality provides fire and police protection of a general character for the public. If special protection of a private character is desired, the cost is met by those who enjoy the special privileges. It is not necessary in every case to connect with the city water mains to enjoy private fire protection.

Special Fire Protection by Independent Plants

This protection can be provided by means of independent or local equipment, such as fire pumps and elevated tanks. A number of manufacturing concerns now provide their own special fire protection in this way and in such cases, they pay the actual cost of it. This cost includes interest on the investment, depreciation, repairs, taxes, fuel used in maintaining steam, extra labor in looking after fire pumps, and also additional labor on Sundays, holidays and at such times as the factory may be shut down. It has been estimated by an insurance expert that the cost of such special private fire protection, when furnished by the manufacturer, would amount, in one particular case to approximately $600 per annum.

Special Fire Protection Connected With Public Water Supply

This service is furnished in cases where the manufacturer does not wish to make the investment for fire pumps, etc., and to employ men to keep up steam on holidays, Sundays and such times as the factory may be shut down.

Connections with public water supply should not be made with private pumping plants having other sources of supplies than that furnished to the general public. Typhoid fever epidemics have resulted in several cities on account of private fire lines being connected with the public water supply and also with contaminated sources through private fire lines. In the city of Lowell, Mass., I understand there were about 25 deaths; in Auburn, N. Y., there was a small epidemic; in Rockford, Ill., there were 40 deaths, although it is said that it was not clearly proven that the fire line connection was to blame. It is reported that typhoid fever epidemics have been caused by fire pumps draughting from polluted sources and seeping through leaky check valves into public mains at Sheboygan, Wis., and Morris, Ill. The public health is of such great importance and human life is so precious that no connections should be made between the public water supply by means of private fire lines and other sources of supply.

Where connections are made with a public water supply for private fire protection, there is a menace to the balance of the city on account of danger of broken sprinkler pipes. There are a number of cases on record where the automatic sprinklers have failed to control the fire and falling walls have broken the large supply pipes, making it impossible for the water works to maintain adequate fire pressure. With a 6 in. supply pipe discharging a full stream, it would be practically impossible for the average water works plant furnishing water under direct pressure to supply adequate fire protection for a second fire in case one should break out at that time. The result of a broken sprinkler pipe might mean a serious conflagration and destruction of a large portion of the city.

It is the opinion of the author that insurance companies will realize this menace before many years have passed and will discourage if not prohibit large connections between the water mains and automatic sprinklers. At the present time, the Committee on Fire Protection of the National Board of Fire Underwriters recommend in congested valued districts, a supply of 7,500 gals. per minute in excess of the domestic consumption and state that this includes an allowance for loss from broken services, elevator, and sprinkler connections incidental to a large fire. This means that in order to provide fire protection which is considered adequate by the underwriters, it is necessary for the water department or company to provide equipment and mains sufficient to take care of a demand on account of broken sprinkler connections. This means an extra investment or cost to the water department or company. If such connections are furnished, the water department or company should receive just and reasonable compensation for such special service.

There should be no question in regard to the right to furnish this service by meter measurement and there should be no connections allowed unless the same are provided with meters. The meters for this purpose should, of course, be subject to the approval of the water department or company. In most cases they should be meters which have been especially designed for fire lines, although there are cases where a compound meter would be satisfactory.

1. *Suggestions for Compensation*—On the basis of the saved insurance premiums. These savings due to automatic sprinklers amount, in some cases, from $1,800 to $3,000 per annum. If the water department or company furnishes the service by which reductions in insurance rates are made, the compensation should be adequate. The reduction in insurance

rates on account of automatic sprinklers in one particular case was from $1.60 per hundred to 20c.

2. The compensation should be equal to the cost to the consumer if such special fire service was furnished independently. This will, of course, include interest on investment, repairs, taxes, fuel, extra labor, etc.

3. Compensation to the water department or company on account of large mains, additional equipment, etc., necessary to provide adequate service to the manufacturer and also for maintaining pressure and standing guard over premises of the manufacturer; under this arrangement, there should be a minimum meter rate on the basis of size of the meter, in proportion to the minimum rates charged for ordinary house meters. Where the water department is standing by, maintaining pressure on the premises of the manufacturer, the compensation should be adequate for such unusual and valuable service.

Rules for Private Fire Protection Lines, Installation of Service, Etc.

1. All private fire protection services will be installed by the company, which will ascertain the best location for them, and lay the pipe from the street main to a point just inside the wall of the building, or within the building line of open yards, where buildings are set back from the building line. The consumer will be charged for time and material, plus 10%.

2. *Size of Service Pipe, Underwriters' Pump*—In all cases, the company shall decide the size of the service pipe. In all cases where underwriters' pumps are to be installed, a suction pipe of sufficient internal area to deliver a quantity of water equal to the full rated capacity of the pipe will be allowed, and no enlargement of said suction pipe inside of the premises will be permitted. If, however, this service pipe is run to a surge tank placed in close proximity to the pump, the full size of suction which the pump calls for may be run from the pump to the tank.

3. *Number of Services*—One service only will be allowed to any one building or premises, unless in the opinion of the company, the general or public fire protection will not be jeopardized and more than one is absolutely necessary for the proper protection of the premises. All fire equipment connected to the company's service shall be confined within the building or on the premises named in the application, and where two or more connections are made for one building or premises, they shall be kept separated, unless special permission is obtained from the company to connect the same in a manner to be approved by it.

4. *Test of Fire Services*—Whenever a fire service system is to be tested under the regulations of the fire insurance underwriters, the consumer must notify the company of such proposed test, naming the day and hour when the same is intended to be made, so that, if desired, the company may have an inspector present during the test.

5. *Contamination of Water Supply*—Any fire protection system supplied with water from the company's service shall be supplied exclusively with such water, and no connection will be allowed with any other system drawing its supply from any other source whereby the company's water supply may be contaminated by the failure to close valves, or leaking check valves, etc., and no auxiliary or secondary suction pipe to any underwriters' pump taking water from wells, streams, or other source whatever, will be permitted. Any fire protection system using water from such wells, streams, or other source than the company's service shall be kept separate from any such system supplied from the company's service.

6. *Inspection*—All fire services shall be subject to inspection by the company from time to time, and the consumer shall give the inspectors all reasonable facilities for making the inspections, and any information concerning the same that the inspector or the company may require. Care will always be taken that inspections will be made with as little inconvenience to the consumer or occupant as possible.

7. *Approval of the Chief of Fire Department*—All applications for private fire protection shall be subject to the written approval of the chief of the fire department of the city, who in such approval, shall state that, in his opinion, the public fire protection will not be endangered by the connection proposed to be made by the company, when properly safeguarded by the placing of an indicator post valve as near the main as possible, said valve to be under the control and orders of the chief of fire department at time of fires, with full authority to close said valve.

8. *Guarantees*—The company, or department, in no manner guarantees to furnish a proper quantity of water through fire protection services, nor does it undertake to guarantee anything relative to such service, but it will endeavor to maintain the efficiency of its service under all conditions. The granting of a permit for private fire protection is under the express condition that the company shall not be considered or deemed in any manner to have undertaken to extinguish fire or to protect any person or property against loss or damage by fire or otherwise, the said company not being an insurer of persons or property, and that it shall be free and exempt from any and all claims for damages on account of any injury to persons or property by reason of fire, water, failure to supply water or pressure, or for any other cause whatsoever, and that in the event of the destruction of the premises of the consumer, then the contract between the company and the consumer shall immediately cease.

9. *Plans and Drawings*—The consumer will furnish an accurate sketch showing the pipes, valves, hydrants, connections, and appurtenances on the premises of the consumer and connected with the mains of the company and also an accurate sketch of any other water pipe system and fixtures that may exist on the premises.

References to Court Decisions Concerning Private Fire Protection

"The principal subject of the defendant's water board in requiring fire service pipes to be metered is to prevent the surreptitious or careless withdrawal of water through such pipes for other purposes than the extinguishment of fires; another object is to procure the measurement by meter of all water consumed for any purpose in order to check wastage and to require each taker to pay for the exact quantity of water furnished to him. * * *

Both upon principle and authority we are of opinion that under circumstances like those before us it is not unreasonable to require the installation of a meter at the plaintiff's own expense in its private fire service pipes.

Nor can it be said that this regulation imposes undue burden upon the plaintiff. The defendant has afforded reasonable means of extinguishing fires by public hydrants; if the plaintiff desires in addition a private system for the protection of its own buildings, it is not unfair for the defendant to impose, as a condition of supplying without other charge, water to make this system available, the requirement that the plaintiff shall take this water only through a meter to be put in at the plaintiff's expense."

Shaw Stocking Company v. City of Lowell. (Supreme Judicial Court of Massachusetts; Middlesex. May 22nd, 1908. 85 Northeastern Reporter, 90).

"These authorities are cited to show the views of courts of high authority, and for the further reason that they are in harmony with the conviction of all men who have thought seriously upon this subject. There is no perceptible reason why the water company should be compelled to provide and maintain a sufficient supply of water to operate the water sprinklers in time of fire for private individuals, without compensation. On the contrary, this special benefit to the property owner over and above what the municipal fire protection affords the people in common, should be paid by the private user."

Indiana Public Service Commission in the case of Commercial Club of Terre Haute vs. Terre Haute Water Works Company, decided Dec. 18, 1915.

"The proprietor of a building, who installed therein an automatic sprinkler system, intending thereby to put out fires before they could gain headway, derives benefit from the system in fire protection and reduced insurance rates, and though there be a general benefit in reducing fire hazards, yet a municipal water works system to which the sprinkler is attached performs a service, and stands ready to perform others for which charges may be made.

It is evident that payment for the small quantity of water used would be wholly inadequate as compensation for the pressure required, and the readiness at all times to serve and the inspection of the city which might well be exacted."

Edgerly vs. City of Ottowa, 156 N. W. 388, decided Feb., 1916, by the Supreme Court of Iowa.

Action to restrain city from placing a meter on fire extinguishing plant dismissed by Appellate Division of the Supreme Court. Judgment affirmed with costs.

American Mfg. Co., Appellant v. City of New York. Court of Appeals of N. Y. Jan. 27, 1911.

"A water company which supplies the pressure and water for an automatic sprinkler for a private corporation performs a service which is not included under its contract with the city to supply water for fire protection and has the right to make a reasonable charge therefor against the corporation."

D. B. Loveman Co. vs. City Water Co. 1 Tenn. Ch. App. 596.

"In the matter of furnishing water to its citizens, a city when authorized by its charter acts in a private rather than a governmental capacity and has the same right to make reasonable charges therefor that a private corporation has when serving the public."

St. Louis Brewing Ass'n vs. City of St. Louis, 140 Mo. 419 —37 S. W. 525, 41 S. W. 911.

"A rule, providing that water meters might be installed at the pleasure of the water board on the consumer and that after they had once been installed, the consumer could not thereafter return to the flat rate, is reasonable and may be enforced where the meter rates are reasonable and no discrimination between consumers is shown."

Powell vs. Duluth 97 N. W. 450.

"The law imposes no duty to insure the property or extinguish fires."

Woodberry vs. Tampa Water Co., 57 Fla. 243, 49 So. 556.

The Arizona Commission in fixing rates to be paid to a water company, decided that a mining company desiring a private fire protection system, should be required to pay a fixed demand charge although "the actual water consumed for this purpose is likely to be negligible."

Arizona Corp. Com. vs. Morenci Water Company, Public Utilities Reports, 1915, C. 525, 527.

"A great deal has been written upon the subject of charges for private fire protection, such as service for inside private hydrants and sprnkler systems. It seems to be the consensus of opinion of operators that a minimum charge is entirely reasonable based on the idea of the "ready to serve" proposition. It is obvious that a manufacturing establishment or other business installs such private fire service equipment for the special security of its own property over and above the protection undertaken by the water company for the benefit of the public. For this reason it might be equitable to assess some charge for this service varying with the size of the connection. In the present instance, it appears that the water utility will be justified in metering all services installed for the purpose of such protection, not with the idea of charging for water used in case of fire, but for protection against surreptitious use as close inspection and supervision have been found in many cases to be inadequate."

Beloit vs. Beloit Water, etc., Co., Public Utility Reports, 1915, B. p. 1005, 1020.

"We do not doubt the power of the city, through the Board of Water Commissioners, to select water meters and install them in residences at the expense of the consumer. It is a matter of common knowledge that where water is supplied without limit, at a stated price, many consumers waste it. The knowledge that the quantity used will not affect the price, begets indifference and encourages negligence. Nothing affords a better check on this fault of a large part of the human family than self-interest. So, therefore, the installation of devices through which it may be known what quantity of water a person uses and whereby he may be required to pay in proportion to the quantity, are considered to be reasonable regulations. The good effect of such regulation is double. It leads to the payment of each person for the quantity he consumes and it protects the general supply."

Mallon et al. vs. Board of Water Commissioners, 128 S. W. 764.

"The benefit received was not incidental, but it was the result of a direct appropriation by the furniture factory of power and water, which was the property of another, as a standing guard over its property against the peril or destruction by fire. Connection with a light or water plant accompanied by the asserted right of using it and the means of exercising the right is a benefit enjoyed at the hands of another imposing an obligation to make reasonable compensation although the occasion for actual use never arises. Here there was not only the connection, the asserted right to use it and the means of exercising the right affording continual protection against fire, but there was a positive saving of insurance bestowed upon the furniture factory by the water company. The fact that there was no use, no actual consumption of water, is a factor to be considered in estimating what should be the amount of compensation, but it does not relieve the furniture factory from liability for the fire protection furnished at the expense and labor of the water company."

Cox v. Abbeville Furniture Co. 54 S. E. 830.

"So long as water supplied for protection against fire is a purely public service, under the control and management of municipal authorities generally, and under the fire department specifically, no direct charge to individuals is proper. When, however, a sprinkling connection is made with private premises the situation is materially different. These premises and the primary causes of catastrophe to the building and of the consequent possible use of disastrous quantities of water are primarily under the control, not of the public, but of the owner. A peculiar personal service is provided for his benefit, which is not enjoyed in common by the community in general, but is available only to a limited class of individuals. It does not advance the reasoning in this connection to split hairs between the 'use' and the consumption of water. As a matter of good sense the property owner beneficially employs the water mains for his own purposes and to his own advantage, although he may not, except in case of fire, actually draw any water from the pipes. It is necessary and proper that for this he should pay. In effect he gets something of pecuniary value from another, which that other is not compelled to give except on the basis of contract. That the law requires the terms of that contract to be reasonable and impartial or that advantage is mutual and involves no expense, is merely incidental or collateral. The conclusion is reached that a charge can be made. How great that charge should be in the view here taken is not before us."

Gordon v. Doran, S. L. R. A. (N. S.) 1049. The same case is reported in Ill., N. W. 272.

Acknowledgment

The foregoing paper was presented at the recent annual meeting of the Indiana Sanitary and Water Supply Association.

Automatic Device for Dumping and Righting Tiltable Cars

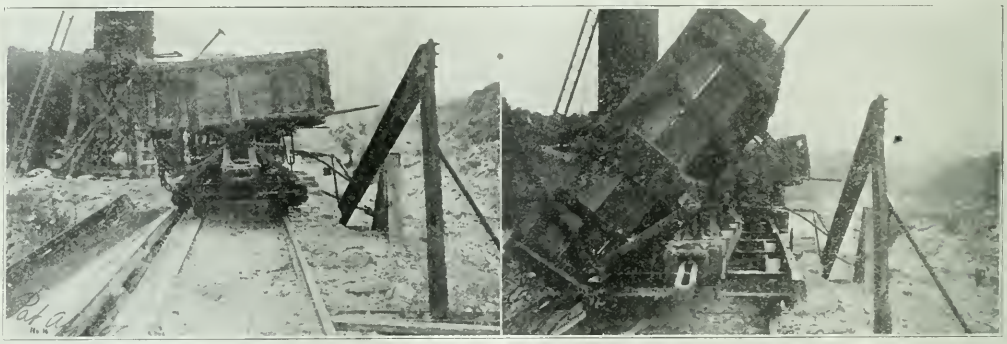
The dump car here illustrated is equipped with an automatic device for dumping tiltable cars upon their reaching a certain desired position, and for righting the cars upon their being moved away from this predetermined dumping position. The cars are normally held against possible accidental tilting. The dumping mechanism is of simple structure and may be added to the various types of dump cars on the market with but slight structural modifications. The device is known as the Druecker Automatic Dumping Device. It has been thoroughly tested out under service conditions and has fulfilled expectations. It is both a time and labor saver.

This device can be placed on cars up to 16 cu. yds. capacity, and it is claimed that four cars can be dumped in from 9 to 12 seconds and righted again and made ready for loading in five seconds.

It is especially interesting to know that the train of cars does not come to a stop during the operation. The dumping point can be shifted in about 10 minutes' time. The dumping mechanism is actuated by the tripping device set in the ground at the side of the track, which pulls a "trigger" in the mechanism attached directly to the car. As the car moves along the track, the dumping mechanism on the car, striking the fixed dumping rail at the side of the track, first dumps the car and then rights it again.

This device, for dumping industrial cars, is sold by the American Investment Company of Washington, D. C., and is the invention of Joseph M. Druecker, Kokomo, Indiana.

In the two views shown herewith, the mechanism is clearly illustrated. The views illustrate, respectively, the position of the mechanism and of the car body before and after dumping.



VIEWS ILLUSTRATING BEFORE AND AFTER DUMPING POSITIONS OF INDUSTRIAL CAR, EQUIPPED WITH BRUECKER AUTOMATIC DUMPING, RIGHTING AND LOCKING APPARATUS.

The One-Man Collapsible Culvert Form Proves Successful in Actual Use

A new culvert form, called the One-Man Collapsible Culvert Form, was briefly described in the February, 1918, issue of this magazine. At that time the form had given promise of success and was endorsed by its early users. The manufacturers made strong claims for the use of this form as a saver of time, money and material. These early promises have since been fulfilled, and numerous county engineers, county surveyors and county and township highway officials have given their full endorsement to this culvert form after giving it a thorough trial in their localities.

The One-Man Collapsible Culvert Form comes in four sizes, with which 91 different culvert openings can be made. It derives its name from the fact that it can be handled and collapsed by one man. It entirely eliminates the use of wood bracings in the building of concrete culverts with either flat slab tops or arched roofs.

The forms, which are made of steel, come in four sizes covering cross sections of from 13 x 16 ins., to 60 x 70 ins. For larger culvert openings two forms may be placed abreast or stacked. For a 30 ft. length four sections are used, spaced 4 ft. apart. If a concrete bottom is desired the concrete is mixed stiff and supporting planks are laid on the green concrete. When building culverts too small for a man to enter wires are attached to the cross rod and center bar in order to collapse the frame and remove it from the culvert. To keep the lumber and forms clean, tar paper is laid over the forms before depositing the concrete.

Experience has demonstrated that by the use of this culvert form box-shaped concrete culverts can be built at a saving of 25 to 50 per cent. as compared with the cost of building the same culvert, using wood bracing which must be sawed, fitted, nailed up and finally torn out after the concrete has set. Not only does the use of this form save time, labor and lumber costs, but because of its strength and dependability prevents the cracking of the concrete.

Like other successful equipment and devices available to the builder, this culvert form is a development based on experiments. It was placed on the market to decrease the expense incurred in using wooden forms over which to pour concrete culverts. This metal support can be used many times. If handled properly it will last indefinitely. Experiments were at first made with sheet metal for a casing, but it was found that such a casing would sag. There were other objections to the use of a metal casing, so it was finally decided to use lumber as a casing, as it is available everywhere and is much more satisfactory in every respect than a metal casing. The collapsible steel form work used in conjunction with the lumber casing is made in sections and every section is complete in itself. A section has no loose parts, separate trips, screws or braces. These culvert forms are the invention of George W. Storms, and are manufactured and marketed by the Storms Manufacturing Company of Crawfordsville, Indiana.

The form is made entirely of steel, reinforced, and is so constructed that it will rigidly support a great weight without slipping or buckling. By an easy pull on the control rod it will collapse and can easily be withdrawn from a culvert by one man. It takes only a few minutes to place the form and lay the wooden casing over it. It can be operated by unskilled labor. The time, labor and money saved on the first two jobs often pay the cost of a set of these forms.

EDITORIALS

Resist Pressure for Cheap Construction

The engineer should now, more than ever, resist the pressure brought to bear on him by taxpayers and non-technical officials in favor of cheap construction. In ordinary times this pressure is considerable, and it reaches its greatest intensity in times of abnormally high prices, like the present time. There are many evidences that the uninitiated are agitating for shoddy construction to offset, in part, the advance in the cost of high-grade construction.

The engineer who yields to this sort of pressure lets himself in for a vast amount of trouble. Those who are most insistent that he adopt inferior materials to save money are the first to condemn him when these materials fail to give satisfaction later on.

The surest thing we know after years of close study of public improvement activities is that the poor improvement never gives satisfaction, no matter how low its cost, and the good improvement always gives satisfaction, no matter how high its cost.

When an improvement is proposed, both its cost and its probable performance are considered, but after the improvement is placed in service its cost is quickly forgotten and its performance alone remains of interest to the public.

Why Some New York Road Contractors Defaulted

During the year 1918 the New York State Highway Department completed a number of road contracts on which the contractors had defaulted. One of the polite fictions of the season was that these contracts were abandoned "on account of the war." What a multitude of sins that war has been made to cover!

It is most illuminating, however, to read more of these abortive contracts in the annual report of the Supervising Engineer. He says:

"It is the current custom to ascribe failure on public work operations to the war, but this reasoning was only partially responsible for the various contracts which the department was forced to complete. Most of the failures can be traced back to the ruinous competition of 1914, 1915 and 1916, brought on by the influx of many inexperienced contractors. In some cases a certified check for bidding purposes was obtained from a bonding agent; a bond procured from this agent's company; a plant bought for a few dollars plus six, nine and twelve-month notes; the president of some rural bank procured as a co-partner so that the first payrolls might be met; and finally the proceeds of monthly estimates were assigned to material manufacturers so that work could proceed. Such combination as outlined above, together with the gradual increase in the cost of labor, had far more influence upon the resulting abandonment of contracts than the entry of the United States into the world war."

The irresponsible low bidder is, as we have before remarked, the cause of much grief to others as well as to himself. Making no allowance for contingencies and adverse weather and labor conditions, he bids so low that he breaks himself or somebody else, or at least forces prices down to a level where all legitimate profits disappear. It is a plain duty of the engineer to advise the public to beware of the lure of the low bid filed by the irresponsible low bidder.

Make the National Highway Bill a Law

The National Highway Bill, commonly referred to as the Townsend Bill, was introduced in the United States Senate on June 2 by Senator Newberry, of Michigan, acting for his colleague, Senator Townsend. The bill was promptly referred to the Committee on Post Offices and Post Roads.

The bill is designed to establish a national highway system, to create a Federal Highway Commission, to encourage efficient and economical highway transportation, and to accomplish other purposes.

The bill embodies the national policy and plan promulgated at the joint meeting of the American Association of State Highway Officials and the Highway Industries Association held in Chicago last December.

All those who have made a study of this question and believe that it is for the best interest of each state and of the nation to create a Federal Highway Commission to establish a national highway system, should use their influence to have this bill enacted into law. It is officially designated as Senate Bill 1309. Write your Senators and Representatives in support of this most constructive measure.

The Price Conspiracy

The public official who cannot satisfactorily explain the present high prices prevailing in the improvement field must be strangely barren of ideas and bereft of information. All prices are high; the prices of most commodities are relatively higher than those of public improvements. This is not an unsupported assertion made in the interest of the construction industry, but is a statement of fact based on statistics compiled by the U. S. Department of Labor and recently made public. Here is just one sentence quoted from that high authority:

"At the close of the war the index number for building materials, not including steel and other metal products, had risen only 61 per cent. over the pre-war prices of 1913, while the index number for commodities, exclusive of building materials, had risen 113 per cent."

Occasionally some reader of this journal writes to us accusing us of aiding and abetting a high-price conspiracy in the interest of patrons of the magazine. This attitude is ridiculous. If we were alone in urging the making of improvements at present prices, our motives might be questioned, but there are numerous disinterested authorities, both in and out of the public service, who are urging the people to build now without awaiting the return of low prices, which may be years in arriving, if they ever do arrive. For example, the Director General of the U. S. Department of Labor recently said: "Business is being held back and the nation's resources of human and mechanical produc-

tion wasted because of the existence in some quarters of an unreasonable fear of a sudden price recession. Careful study of all the precedents and present economic factors points toward a very slow and gradual price readjustment."

Many other authorities could be quoted, including John Hays Hammond and Maj. Gen. George W. Goethals, to show that if there is a price conspiracy and we are in on it, we are at least in good company.

Will the American Association of Engineers Adopt Trade Union Methods?

As in recent issues, we shall continue having a good deal to say in these pages about the American Association of Engineers. Not only are we fully and finally convinced that the association is already a tremendously successful going concern, but this year the association is planning to co-operate with public engineers to secure for this class of engineers better employment conditions, including greater compensation and greater security in office. Since this magazine is devoted to the interests of the engineer in public service, it is our clear duty to co-operate with the association in this work.

In all frankness it must be admitted that in coming to the aid of the association at this time we are, as the Europeans say, "merely succoring the victor." The association is already a victor, having risen to great heights from a most humble origin. All we can hope to do is to assist in reducing to a minimum the time yet required by the association to draw all engineers to it and to gather the full fruits of its victory over inertia, reaction and prejudice within the profession.

There still persists in some quarters, among those who have not fully informed themselves in the premises, the belief that, simply because the association is exercising organized effort on behalf of the engineer, it is about to adopt or has already adopted trade union methods. The engineer need have no fear that the association will adopt any method that will reduce the profession to a trade.

The editor was not the only one who looked on from the side lines for a good while before deciding to co-operate with the association. Recently a prominent railway paper published an editorial entitled, "Shall Engineering Be a Profession or a Trade?" In a letter commenting on the editorial the chief engineer of one of America's greatest railway systems said:

"You say the American Association is patterned in many ways after the trade unions. Before deciding to join the American Association I studied this very carefully, as I am strongly—I might say violently—opposed to the introduction of trade union methods into an engineering organization. I was thoroughly satisfied that the American Association, beyond being a business organization, as is the United States Chamber of Commerce, had nothing in common with trade unionism and had no intention of adopting trade union methods."

Such testimony should refute the baseless charge that the association is merely "a glorified trade union."

Convinced of the Necessity for Organization

Engineers in public service who are interested in improving their conditions of employment will not fail to read the article in this issue that tells how the engineers and draftsmen in the municipal service at St. Louis turned to the American Association of Engineers for help, after trying vigorously but vainly to get justice without being organized. The men turned to the association because, says the author of the article, "they were convinced of the necessity for organization."

Never before have so many engineers appreciated the need for organized effort as they do today. This is true throughout the country. Local organizations are springing up at various points. Some of these incline toward trade union methods, but the inclination is not likely to be followed for the reason that local leaders are coming more and more to realize that affiliation with a national organization is highly desirable, and they are turning toward the American Association of Engineers, which is not operated on trade union lines.

It is not strange that engineers here and there are discussing organization. They have tested to complete failure the old plan of individual effort. The regulation thing in any line of business today is organization. Organization forces organization. When there are various combinations and organizations in the business world the groups that remain unorganized can expect nothing better than the worst of it in the economic struggle. It is really too late to discuss the desirability of organizing. Engineers are not confronted by a theory this time, but by an accomplished fact.

The American Association of Engineers has been called "the engineer's Chamber of Commerce." It looks after all the business interests of engineers as a class. It will be a great day for engineers when the association has affiliated chapters and clubs in all parts of the country, corresponding to local chambers of commerce, all co-operating with the central organization. Then the engineering profession can speak with a single voice, not only for itself, but in safeguarding public interests in all matters where engineers have expert knowledge.

To oppose organization is to oppose progress, and opposing progress is a peculiarly futile and hazardous enterprise.

Should the Engineer Enter Politics?

To raise a question as to whether or not the engineer should enter politics is equivalent to asking whether or not he should perform the duties of citizenship and whether or not he should obey the law of self-preservation, which is said to be the first law of nature.

Enjoying the privileges of citizenship, the engineer, like other men of affairs, should perform its duties, among which is participation in local governmental activities. The analytical engineer should appreciate the uses of politics as well as its abuses; it would be the better for his participation in it. Many matters of an engineering nature are disposed of through political processes, and assuredly it is the duty of the engineer to engage in political discussions of this sort, where his training and experience fit him to be a leader of public opinion.

The engineer in public service is often made and as often unmade by the rotation of the political whirligig. If he does not participate in politics in such a case, he is leaving his destinies strictly in the hands of other men. He can scarcely afford to assume an attitude of dignified neutrality where his vital interests are concerned.

There is an unusually interesting article in this issue on the engineer in politics. It is just another indication that the engineer is no longer content to take merely a thinking part in the affairs of men. He is looking for more action.

The Design and Construction of Modern Granite Block Pavements With Special Reference to Practice in Borough of Manhattan

By C. M. Pinckney, Chief Engineer, Dept. of Public Works, Borough of Manhattan, Municipal Building, New York City.

FOR the purpose of this article we will consider all types of pavements whose road metal or wearing surface is of granite.

Types of Granite Pavement

There are several types of granite pavement now in use. First, the large, roughly dressed block type laid on a sand, or in some cases a concrete foundation with a cement grout or a bituminous joint filler. Second, the improved, well dressed, small block type laid on a concrete foundation with a cement grout or a bituminous joint filler. Third, the small block type consisting of 4-in. regular cubes laid on a concrete foundation with a cement grout or a bituminous joint filler. Fourth, Durax type, consisting of irregular shaped, roughly cubical pieces of granite fitted together in segmental arcs on a concrete foundation with a cement grout or a bituminous joint filler. Fifth, the reclipped block type; and sixth, the napped block type.

Advantages of Granite Block Pavements

It may be truly said of granite block pavement that it is the only type of pavement that is afforded an opportunity to wear out, rendering adequate service with a minimum of inconvenience to the traveling public every day of its life. In other words, its failure is not induced or aided, as in other types of pavement, by certain inherent characteristics of the material itself, which tend to lend themselves to, rather than resist, certain agents of destruction which are normally present in a large city. It is entirely free from the disintegrating effect of water; it is not affected by gas or steam leaks, and it offers more resistance to small fires than any other type of pavement. It is the only type of pavement, with the possible exception of the waterbound macadam (now a relic of an antiquated past) that offers salvage after many years of service. It is likewise the only type of pavement that is adaptable to extreme conditions of traffic and street gradients combined.

Modern Granite Pavements Are Not Noisy

Objections are sometimes offered against the selection of a granite pavement on the ground that it is noisy, the objectors having in mind the old type of granite block pavement over which the passage of a heavy load caused the buildings to shake, and the windows to rattle. They seem to be wholly unaware that the modern granite pavement is noiseless when completed, and remains so for about two years, after which the joints may be refilled with bitumen at a small cost (about 20c per sq. yd.). Such treatment at intervals of two years will result in a comparatively quiet pavement during the greater part of its life.

Requirements Essential to Good Results with Granite Pavements

A successful granite pavement is only obtained by the observance of a series of details; each detail in itself meriting careful attention in order that the desired effect may be

VIEWS OF GRANITE BLOCK PAVEMENTS, BOROUGH OF MANHATTAN, CITY OF NEW YORK.

Top Row: Modern Granite Pavement on Lafayette St., at Duane Street—Recut Granite Pavement on 79th Street. Bottom Row: Durax Pavement Being Laid on West Street—Old Style Granite Pavement on Washington Street, at Leroy Street.

secured. The granite used must be reasonably hard and tough. In fact, toughness is a more desirable physical characteristic than hardness. It must be a fine-grained, clean-splitting stone. The blocks must be uniform in dimensions, particularly in the width and depth and they must be so dressed that the heads shall slightly cover the blocks and have no irregularities greater than ¼ in. from the general plane of the head.

Dimension of Blocks

The Borough of Manhattan's specifications provide that the dimensions of the blocks shall be as follows: From 6 to 10 ins. long, 3½ to 4½ ins. wide, and 4¾ to 5¼ ins. in depth. In this locality the blocks are inspected upon arrival, and if 15 per cent. of the first thousand blocks, selected at random, are found to be defective, the cargo is rejected. The acceptance of the cargo as a whole, however, does not operate against the culling of individual blocks, while the work is in progress.

Handling the Blocks

Upon the acceptance of the cargo, it behooves the engineer or inspector to see that the handling of the blocks is attended with some degree of care. Nothing is more conducive to the defeat of a good purpose than the careless handling or rehandling of paving blocks. It must be remembered that every time a block is thrown into a pile of blocks, at least two blocks are damaged. Consequently, careless handling or unnecessary rehandling of the blocks should be avoided.

Concrete Foundation Imperative

As the pavement is merely a wearing coat only, capable of resisting the abrasive action of traffic, its behavior under the shocks of impact and the enormous wheel loads, which modern pavement is called upon to bear, is entirely dependent upon the stability of its foundation.

Prior to 20 years ago, it was the common practice—notwithstanding the scriptural injunction against founding our houses upon sand—to found our granite pavements upon a sand foundation. The fallacy of laying a pavement consisting of a number of separate yielding units soon became apparent as the motor vehicle increased in popularity and tonnage capacity, until at the present time, one would as soon think of constructing a pavement in mid-air as he would of laying a pavement without a concrete foundation. But even under the disadvantages of being poorly founded, these granite pavements rendered good service in the past and lasted many years under the light, slow-moving traffic of their time. Now, however, the almost universal use of the fast-moving heavy motor vehicle requires all pavements to be founded upon a firm concrete foundation.

The Concrete Foundation

The concrete used for this purpose should be not less than 6 ins. in thickness. The aggregate should be composed of a well-graded, broken stone or gravel, and the matrix should be a clean sharp sand and a good grade of Portland cement. The materials should be mixed in the proportions of 1 part of cement, 3 parts sand, and 6 parts of stone. A mechanical batch-mixer should be used, and each batch should be carefully measured and mixed until all of the materials are thoroughly incorporated. Before the concrete is deposited, the subgrade should be shaped and rolled until final compaction is assured. The concrete is then deposited in a uniform layer from curb to curb. It should be spread and shaped by raking, and by liberal application of form templates, until the top surface is smooth and parallel to the finished surface of the pavement. It is quite important that the finished surface of the concrete should have no projecting points of stone, as these points will interfere with the proper bedding and ramming of the paving blocks, frequently causing some of the blocks to rock and become loosened or broken after the pavement is completed and opened to traffic.

VIEWS SHOWING CONSTRUCTION OF GRANITE BLOCK PAVEMENTS IN BOROUGH OF MANHATTAN, NEW YORK CITY.
Left: Applying Bituminous Filler. Right: Method of Grouting Reclipped Blocks.

The Mortar Cushion

After the concrete has set, a dry mortar cushion composed of sand and cement mixed in the proportions of 1 to 3 should be spread over the concrete in sufficient quantities only to supply the pavers with a bedding for the stone. The virtue of this mortar cushion lies in the fact that it offers an impervious impedient to any unsuspected small streams of water which would undermine a sand cushion and cause an irregular settlement of the pavement at some later time.

Ramming Blocks the Most Important Detail

After the paving blocks are set in, place stone against stone with close joints not exceeding ⅜ in., the end joints being properly broken, the rammersman proceeds to ram the blocks down to a solid bearing. This is probably the most important detail in connection with granite block paving, as every block should be struck full on the head with sufficient force to drive the block home to a solid bearing without fracturing or spalling it. The rammersman, after thoroughly ramming the whole surface, removes the low blocks by means of tongs, the use of pinch bars being avoided as the action of the pinch bars tend to disturb the alignment of the courses and widens the joints. Sufficient mortar is then placed under the low stones to bring them to the general plane of the surface of the pavement and the whole pavement is again rammed until every stone is well founded and the heads of the paving blocks form a true and unbroken

surface. Should this detail be neglected it will not be discovered until traffic has rammed the pavement, forcing down the blocks that are insufficiently bedded and spalling or cobbling the edges of the high blocks, leaving an uneven paving surface which is destined to early failure.

Filling the Joints

The filling of the joints is also an important item in granite block pavement construction. The joint filler may be a bituminous mastic composed of asphaltum or coal tar, and a finely graded sand, which has been previously heated before mixing, or a cement grout.

Bituminous Filler Exclusively Employed in Manhattan

In some cities local conditions do not permit the use of the cement grout filler as barricading the streets for such a considerable period of time in order to afford the grout an opportunity to harden would seriously inconvenience the business interests in the street and also the traveling public. The necessity for frequent openings and disturbances of the pavement in some cities primarily due to the location of subsurface structures such as water and gas mains, electric conduits, etc., precludes the use of this material for joint filler, as the work involved closely resembles a quarrying operation or masonry excavation, leaving no salvage to temporarily repair the opening until final restoration can be made. Where this filler has been used under satisfactory conditions, it has invariably given excellent results. Because of the aforementioned objections, the borough of Manhattan has been compelled to confine itself to the use of the bituminous paving filler exclusively.

Preparation and Use of the Mastic

Due care must be exercised in the preparation and use of a mastic so as to avoid the errors common to work of this character; otherwise, the resultant product will fail in its purpose and will not come up to expectations. It is essential that the bitumen or coal tar be heated to the proper temperatures (bitumen 300 to 400 degrees F.—coal tar, 250 to 300 degrees F.). Overheating is fatal as it tends to lower the ductility of the material which, upon hardening in the joints, becomes brittle and is quickly broken by the impact and shocks of traffic and is soon jarred out, leaving the pavement unfilled and raw, thus affording traffic an excellent opportunity either to loosen or cobble the paving blocks. Hence, a thermometer should be kept in the tank at all times while it is in use, and should be frequently consulted by the inspector who should see that the tank fire is so regulated that there is no danger of the material overheating. The mineral aggregate of this mastic should be a clean fine sand which should be heated before mixing with the bitumen; the two materials being used usually in the proportion of 1 to 1.

Two Methods of Mixing and Placing the Mastic

There are two methods employed in mixing and depositing the materials of this mastic; one is by drawing the hot bitumen from the tanks in the pouring buckets; adding measured quantities of hot sand thereto, and stirring with a wooden paddle to insure the suspension of the aggregate, the mastic being then poured from these buckets into the joints. This method is crude and not in keeping with the best methods of modern practice. The main objection offered is that the process of pouring the joints is rather slow, sufficiently slow to enable the mineral aggregate to settle in the bottom of the bucket before it is half emptied. The second method is to employ a mechanical mixer and draw the mastic off in carry-alls, dumping it quickly upon the pavement and working it over the surface and into the joints by means of squeegees. This method is by far the more preferable, as the suspension of the mineral aggregate is maintained by mechanical agitation right up to the very moment of its use, and the method of depositing the mastic does not occasion sufficient delay to afford the sand an opportunity to settle. A thin layer of sand should be spread over the finished pavement as protection against the traffic carrying the mastic away, as unlike a grouted pavement, this pavement may be opened to traffic within a few hours after its completion.

Present Excellence of Granite Pavements Due to Co-operation

The substitution of the small granite block for its large mis-shapen predecessor, succeeded in bringing about a radical change in the block-making and paving industries. Where the large block was merely a crude product manufactured by the paving cutter from the grout or waste material of every quarry without serious thought or endeavor on the part of the manufacturer to turn out a product best suited for its intended purpose, the small improved block represents the most finished handiwork of the paving cutters' craft. It is manufactured from quarried dimension stone, only fine-grained granite being selected for the purpose. The labor

VIEW OF CONCRETE FOUNDATION READY TO RECEIVE GRANITE PAVING BLOCK, BOROUGH OF MANHATTAN, NEW YORK CITY.

employed in the manufacture is highly skilled, the whole operation being attended by close supervision and inspection, and the completed paving block is subjected to careful handling and delivery.

The pavers and rammers, also, through the process of industrial education developed by the labor organizations and others interested in good pavements were among the first to co-operate and lend their very necessary assistance toward the perfection of the present granite block pavement, and the paving contractors, too, men who were formerly only interested in large yardage at small outlay with a consequently high percentage of profit, they, too, are imbued with a like spirit of co-operation and a feeling of justifiable pride in the completion of a piece of work that has been well done and in which they have played some part.

The 4-in. Cube Granite Pavement

The small 4-in. cube type of granite pavement consists of granite cubes 4 ins. in dimension. It is laid on the same foundation, and in a similar manner to the improved granite pavement. Except for the purpose of holding an old concrete foundation, this type of pavement is rarely selected in this country—the multiplicity of joints and the small head area of the units being the chief objectionable features.

Durax

This type of pavement has been quite extensively used in some of the large cities of Europe, notably, Liverpool, Hamburg and Berlin. It consists of irregular pieces of granite, roughly cubical in shape, about 3½ ins. in dimension. It is laid in the form of segmental arcs instead of regular courses. The foundation and joint filler are the same as described for other types of granite pavement, though the operation of paving is somewhat different. Like the cube block type, Durax may be well employed as a resurfacing pavement to replace a shallow type of pavement, retaining the old concrete foundation. It has not attained popularity in this country owing to the difficulty of obtaining labor sufficiently experienced in the laying of the pavement, and also due to

that in localities where street openings are frequent it is difficult to repair.

The Reclipped Block Pavement

The reclipped block offers an excellent illustration of how a granite pavement at the termination of its usefulness may be, at a small cost, completely rejuvenated and placed in a condition almost equal to that of a new pavement. The old blocks are removed, and the concrete foundation retained; sufficient concrete being added thereto to raise it to the new grade; to fill in all of the irregularities, and to correct the contour. The old blocks are clipped and dressed at the site

VIEWS SHOWING THE QUARRYING OF GRANITE PAVING BLOCKS.

Top Row: Close-up View Showing how Stone Lays in the Quarry—An Extensive Granite Quarrying Operation in the East. Bottom Row: Showing Regular Formation of Stock as it comes to the Paving Cutter—The Finished Product at the Quarry.

of the work until the finished product closely resembles new blocks in all respects, though somewhat smaller in dimensions. The operation of clipping should be done only by skilled and experienced paving cutters, and it should be attended by the closest inspection; otherwise, the blocks may be napped instead of being clipped. The blocks are paved in a manner similar to that described for the modern granite pavement, and the joint filler may be a cement grout or a bituminous mastic.

The Napped Block Pavement

The napped block pavement is another type of granite pavement constructed from the salvage of the old granite blocks. It differs from the reclipped block pavement insofar as the blocks are merely broken in half and laid with the broken ends up; joints being consequently wide, are invariably filled with a cement grout filler.

Life of Granite Block Pavements

The question of the life of a modern granite pavement is governed by too many variable factors to permit of a direct answer. While it is true that many of the granite streets in New York City today are 25 years old and over, it must be borne in mind that the streets referred to are not important thoroughfares, and that the pavement thereon has only successfully withstood the character of traffic common to its time. How long the same pavement would live under the traffic conditions of today, or the traffic conditions of a few years hence is merely a matter of conjecture, as traffic is rapidly assuming the form of an indeterminate variable to which no known value can be assigned. So far, by the use of improved materials and methods of construction, we have kept pace with the greatly increased traffic conditions, but we are fearful that the motor vehicle manufacturers who are limited only by the wildest swing of their fancy in their efforts to create a vehicle of maximum carrying power at a minimum of cost, will eventually succeed in their purpose to the utter confusion and consternation of the paving engineer, who has about reached the fullest extent of his efficiency in road-building that the somewhat limited supply of those materials having certain inherent characteristics that make them valuable for road metals enables him to reach, unless some reasonable restriction is placed upon the design of these vehicles thereby terminating this unequal strife.

No Excuse for Building Semi-Durable Pavements

"The use of the motor truck has exceeded all prophecies," said H. Eltinge Breed, First Deputy, New York Commission of Highways, in his last annual report. "The war has given it its place. It is a means of transportation coordinate with train and boat. Highways must be built to sustain it. In each of our three previous reports we have pleaded for the building of more durable types of pavement. We now have in this state 1,290 miles of durable pavement of the concrete, brick, asphalt block, etc., types, as distinguished from the less durable waterbound macadams, etc. Henceforth, except in unusually isolated communities, the durable type will be the *only* economical type. The higher first cost of the former will be offset in a very few years by the higher maintenance cost of the latter under heavy traffic. There is no further excuse for building semi-durable pavements in or near settled districts. Their 'cheapness' has, with the advent of the motor truck, become extravagance."

Some Unusual Sewerage Problems and How They Were Solved at Ocean Beach, New York

By Andrew J. Provost, Jr., Consulting Engineer, 39 West Thirty-eighth Street, New York City

While nearly every sewerage system has in its design or construction at least one feature that distinguishes it in some respect, it is not often that the engineer is confronted with so many unusual and interesting problems as presented themselves in the Ocean Beach, N. Y., system constructed in 1916-1917 under the writer's plans and supervision.

Local Conditions

The settlement, which is a purely summer colony, occupies a strip of beach between the Atlantic Ocean and Great South Bay, about 40 miles east of New York City. On the ocean side important sand dunes, some 20 to 25 feet in height, rise abruptly from the storm surf mark and form a natural barrier against inundation of the property at times of excessive tides. In all other portions the surface, which is fine alluvial sand, is substantially flat and, except where occasional secondary dunes occur, is only slightly elevated

FIG. 1. PROFILE OF OUTFALL, MAIN TRUNK LINE SEWER AND TYPICAL LATERAL SEWER, OCEAN BEACH, NEW YORK.

above the high tide level. The mean tidal range in the ocean is about 4½ feet and in the bay about 15 inches. The ground water, which consists of a thin layer of fresh water of natural potable quality floating on a deep bed of salt water, is in almost all places within a few inches of the surface of the sand, and after heavy rains rises sufficiently to cover, for a period of several days, considerable areas of the surface. All buildings are elevated on posts or piers and cellars are entirely absent. Where the use of cesspools had been attempted they were a complete failure, and the employment of scavengers for the daily removal of the human wastes was quite as unsatisfactory.

Design Features

When a system of sewerage was discussed, in 1915, it was promptly recognized that all the sewage must be pumped and that tidal disposal was necessary. It was also recognized that on account of the bathing beaches on both the ocean and bay water fronts, treatment of the sewage would be required to secure at all times a substantially sterile effluent. Careful consideration was given to the feasibility of constructing and maintaining an outfall sewer in the ocean, but, after a careful study of all such attempts made during the past 30 or 40 years at the New Jersey sea shore resorts this project was abandoned as impracticable. The problem was then reduced to constructing sanitary sewers in fine sand and water to a point where the sewage could be suitably treated and pumped into the waters of the bay. The general topographical and drainage conditions are shown in Fig. 1.

Influence of Ground Water on Design

It was fully anticipated that great difficulties would present themselves in performing the necessary excavations, some of which would be more than 20 ft. below the ground water table and in fluid sand, and that, with the excavation problems disposed of, special precautions would be required to prevent excessive infiltration of ground water into the sewers through the joints and at manholes. The employment of cast iron sewers with lead joints, such as had previously been used by the writer with good results under similar conditions at Neponsit Beach, was recommended, in the deeper portions of the work, in the interest of future economical operation in the matter of pumping and treatment. In view of the immediate expense involved it was, however, decided to use vitrified clay pipes in 3 ft. lengths with bituminous joints in all cases where the pipes were laid below the ground water level. No limit regarding permissible infiltration was specified, but the contractor was obligated to to use all practicable precautions and measures to secure substantial tightness of the sewers and other structures. For the sedimentation tank and pump well, which required specially deep excavations, into the water table, the contractor was given the option of constructing coffer-dams or of building these circular fero-concrete structures by sinking them in place as caissons. No water proofing was called for except the use of 10 lbs. of "Ceresit" compound in each cubic yard of concrete.

Construction of the Imhoff Tank

The sedimentation tank, which is of the "Imhoff" type, was commenced by constructing a timber cutting-edge on the surface and loading thereon by means of inside and outside circular forms, an annular section of the exterior wall, complete with reinforcement, 4 ft. high. When the concrete had set sufficiently to permit releasing the forms, they were raised and another annular section was poured on top of the first. When the caisson had been constructed to a height about 12 feet above the surface, as shown in the accompanying photograph, Fig. 2, excavation was commenced on the inside by a bucket operated by a stiff leg derrick with gasoline engine drive. The hole was unwatered with a 3-in. centrifugal pump delivering about 350 gallons per minute. The structure settled evenly and without any trouble whatever and the wall was then completed in the manner described. The finished curb was level and within a fraction of an inch of the intended grade. Openings, temporarily closed with timber bulkheads, were cast in the wall to receive the proposed inlet and outlet connections.

When the contractor attempted completely to unwater the excavation for the purpose of laying the concrete floor, or bottom, it was found that the flow of sand could not be controlled or lowered below a point which, in the middle, was somewhat higher than the bottom of the cutting edge. This difficulty was finally overcome by allowing the excavation to refill with

FIG. 2—PORTION OF CAISSON OF IMHOFF TANK BEFORE LOOSENING, OCEAN BEACH, N. Y. FIG. 3—VIEW OF SUPERSTRUCTURE OF IMHOFF TANK.

water and by removing the remaining excavation with an orange peel bucket working under water. With this balanced water pressure it was possible in this manner to remove the sand under the cutting edge and from all parts of the excavation so as to conform quite accurately with the proposed bottom which was an inverted truncated dome.

Concrete was then lowered through the water in a bottom-dumping bucket and deposited as evenly as possible to a depth of about 18 ins. Full length pieces of ¾ in. steel reinforcing bars were then lowered with ropes and adjusted in place with ends under cutting edge and spaced 6 in. centers in both directions. The remaining concrete was then deposited in the same manner. The bottom was completed Dec. 24, 1916, when the work was shut down for the winter. In March, 1917, the tank was unwatered and was found to be substantially tight under an outside water pressure of about 24 ft. The total leakage was, in fact, not more than ¼ gal. per minute, and most of this was traceable to the timber bulkheads.

The pump well caisson, which was 14 ft. in diameter and 15 ft. deep, was constructed in the same manner and with equally good results.

Laying and Jointing Sewer Pipe

The laying and jointing of the sewer pipes proved to be the most difficult problem of the entire work. The depth of these, where laid in saturated sand, varied from 2 to 7 ft. below the surface. The pipes were vitrified salt glazed tile in 3 ft. lengths with extra wide and deep sockets. Three lengths were jointed on the surface with "S. P. C. Pipe Seal Compound," a bituminous product prepared by the Standard Paint Company of New York City. These joints were poured at about 300 degrees F. temperature, with the pipes in a vertical position, as shown in the photograph, Fig. 5. The joints thus made could be rigidly inspected, and it is believed they were all of excellent character. The handling of these jointed sections while lowering them into place in the trench was carefully performed and no evidence was found to indicate that any of these joints were injured in this manner.

The trenches were sheathed in most cases with 3-in. tongue and grove timber, but it was found necessary to use steel sheeting for the deepest trenches. The work was not begun at the lowest point in the system, near the pump well, as strongly recommended by the engineer, but was attacked in various small sections, between adjacent manholes. The trench water was removed by diaphragm pumps driven by gasoline engines, supplemented in the deeper trenches, where the ground water was excessive, by a 3-in. centrifugal pump. Seaweed was used to caulk the leaks in sheeting and sod dams were used to control the continuous flow of water in the bottoms of the trenches. In spite of these precautions it was found impossible to lower the trench water much below the spring line of the pipe on account of the flow of sand with heavier pumping, and most of the trench joints were poured with the pipes at least half full of water.

No tests could be made for leakage until the entire system of sewers was completed and connected up, but each joint when poured was examined to ascertain that the jointing material extended throughout the entire circumference of the joint. Such joints as did not show this result were usually due to cooling of the compound before the joint was run and in all such cases the bitumen was removed while still plastic and the joint was rerun. Spurs for house connections were laid on average distances of about 40 ft. apart, and house connection branches were extended from these to an elevation above the ground water level in the manner shown in the accompanying illustration, Fig. 6.

Manholes

Manholes were constructed about 175 feet apart on the deeper lines. These were of concrete, 4 ft. square with 8-in. vertical walls covered by a 4-in. precast concrete slab with cast iron manhole ring and cover. Attempts made to pour the bottoms of these manholes in place failed, due to the cement being washed away by the water of infiltration, and it was found necessary to precast these bottoms on the surface and to lower them to place with claims operated with differential pulley blocks. With this procedure the manholes were successfully constructed and would, no doubt, have retained their positions if the contractor had planned his work to make all the connections to each manhole at one operation. Three separate connections were made in several instances, lasting over a period of a number of months, and, with the repeated removal of sand in pumping operations, several of the manholes settled from 2 to 4 or more inches, and in some cases probably ruptured the joints, if not the body, of the connecting piping. As this settlement was more or less uniform it had no serious effect upon the hydraulic gradient, but it did destroy many of the efforts made to secure a reasonably tight sewer system.

FIG. 4—PUMP WELL CAISSON IN FINAL POSITION REMOVING LAST EXCAVATED MATERIAL WITH ORANGE PEEL BUCKET WITHOUT UNWATERING CAISSON, OCEAN BEACH, N. Y., SEWERAGE WORKS. FIG. 5—VIEW SHOWS PROXIMITY OF MAIN SEWER TO TIDAL BASIN.

Excessive Leakage in Sewer Lines

As heretofore stated, no evidence of leakage in the deeper sewers could be secured prior to the completion and joining together of all the several sections of sewer which had been independently constructed. Upon such completion attempt was made to pump out the system with the pumping engines provided for permanent service, and which had a capacity of about 250 gals. per minute, but this capacity was insufficient to unwater the system. With the assistance of the construction pumps the pipes were completely emptied and the infiltration of ground water under this condition was estimated to be in excess of 300 gals. per minute, equivalent to more than 200,000 gals. per day, per mile of sewer, instead of about 30,000 gals. per day per mile, the amount contemplated when the system was designed. This leakage was declared unreasonable and the contractor was called upon to take such steps as necessary to abate the excessive infiltration. Without disclaiming responsibility the contractor contended he was unable to proceed and, acting under the advice of the engineer, the sewer commissioners undertook the work of repairs.

Locating Leaks and Grouting Under Pressure

Preliminary tests made with solutions of coloring matter (uranine) showed the principal leakage was confined to a continuous stretch of sewer about 1,200 ft. in length, representing the deepest section of the work. Estimates of the cost of excavating for and rejointing this line amounted to approximately $3,500. In view of this cost and of the necessity which existed for placing the system in service before such extensive work could possibly be performed, it was determined to experiment with cement grout forced with a pump into the sand in the vicinity of certain known defective joints. The method employed was to excavate a small hole, a few inches deep, over a joint and down to the normal ground

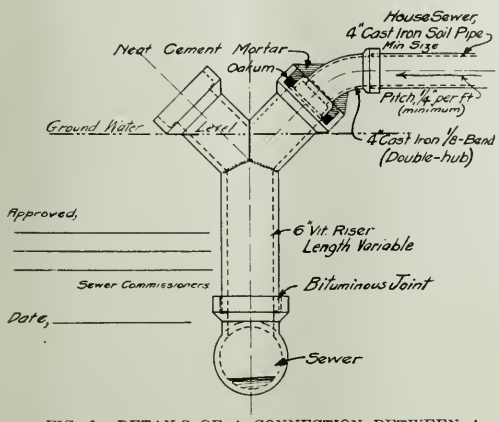


FIG. 6. DETAILS OF A CONNECTION BETWEEN A HOUSE SEWER AND A CONNECTION SPUR IN A STREET SEWER, OCEAN BEACH, N. Y.

This Design also Applies to Connection Spurs Without Risers.

water level. In this shallow pool a small amount of uranine was placed and, if upon starting the pumps the coloring matter was found at the nearest manhole, the joint was considered defective and grout was applied, through a nozzle attached to line of hose, below and around the joint until the color failed to show at the manhole. This test was quite rapid, since a very brief application of the grout was in most instances immediately followed by the absence of color in the stream flowing through the sewer.

This experimental work was continued for about 2½ days in the upper 250 ft. of the defective section and resulted in substantially stopping the infiltration of ground water in that section. One of the useful observations made during this experimental work was in demonstration of the extremely local influence of a defective joint upon the ground water level vertically above it. This was brought out by noting the depression of the ground water, which always existed over a defective joint when the drainage pumps were operating and also noting that as soon as the joint was made tight the water in the test hole above it immediately rose. This phenomenon suggested a plan for rapidly ascertaining the location of all defective joints in the remaining section and for eliminating the necessity of the color test. The application is shown in the upper part of Fig. 7, which is a profile of the ground water vertically above each trench poured joint while pumps were operating. This profile not only showed the location of each defective joint, but also the relative extent of the defect. Excessive depressions of the ground water such as existed at manholes A, B, C, E and F were assumed to represent ruptured or broken connections.

Results of Grouting

With this information a force of three men, one to mix grout and operate the hand pump, one to operate the nozzle and one to observe results and direct the work, completed grouting about 1,200 lin. ft. of sewer and ten manholes in two weeks, at a total cost of less than $300. This cost included the experimental work, the purchase price of force pump and hose, gasoline for drain pumps, cement and all labor except engineering supervision.

The only trouble encountered was with fractured pipes at manholes, where, in some cases, it was necessary to saturate the sand with grout for considerable distances from the break. In the cases of manholes B and C, it was at first found that, with nozzle applied close to the joint, the entire content of the grout barrel was siphoned by the flow of water into the sewer. In such case it was necessary to commence grouting at some distance away, and in this way gradually to shut off the flow of water before approaching the joint. The information furnished by the profile was found to be accurate, even to the extent of indicating the particular sides of manholes B and C, where ruptured pipes existed.

In the lower part of Fig. 7 is shown the profile of the ground water at the same points taken at the conclusion of the work when the tidal and pumping conditions were substantially the same as in the case of the first profile. In the absence of leakage, the ground water profile should be level and at about elevation zero, mean high tide. The final profile falls short of this and indicates clearly that the repairs performed were not entirely effective in preventing all leakage, which was the case. It does demonstrate fully, nevertheless, that the serious defects were substantially remedied and there was no doubt expressed at the end of the work as to the possibility of reducing the joint leakage to any desired minimum by continuing the work along the same lines. It was felt, however, that a reasonable result had been secured and that moderate distributed leakage, consistent with the pumping capacity available, was desirable in its result in slightly lower-

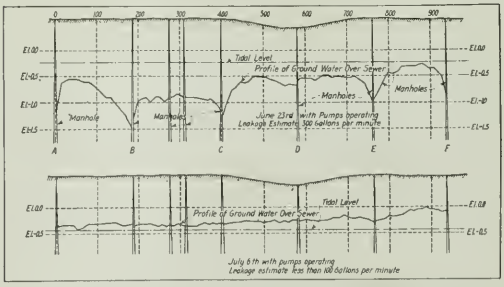

Tidal Level
Profile of Ground Water Over Sewer
Manhole
Manholes
June 23rd with Pumps operating
Leakage Estimated 100 Gallons per minute
July 6th with pumps operating
Leakage estimate less than 100 Gallons per minute

FIG. 7. DIAGRAM SHOWING EFFECT OF GROUTING AROUND JOINTS IN 1,200 LIN. FT. OF DEFECTIVE PIPE SEWER.

ing the ground water table, which, in some sections of the property, produced surface pools, particularly after rainfall.

Bituminous Joints and Grouting

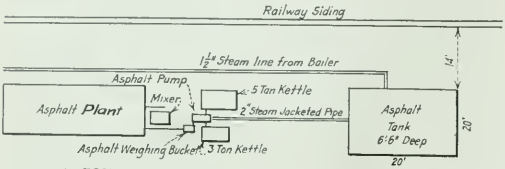
The writer must confess he has in the past been somewhat apprehensive regarding the durability of bituminous compounds in sewer pipe joints, and has often felt the possible failure of these materials, after a few years contact with water and sewage, might prove decidedly unpleasant to those who now find their use so convenient. As the result of the experiences herein described he now feels the use of these materials, in water-bearing sandy soils, is entirely justified, since a rapid and economical method exists for repairing the joints, if excessive leakage should thereafter develop through disintegration of the bituminous compounds.

How a Contractor Equipped His Asphalt Plant to Dispense with Two Men and Lower Cost of Asphalt

By Morgan R. Butler, of Butler Construction Co., Waukesha, Wis., Temporary Address P. O. Box 237, Lansing, Mich.

The Cummer Road Asphalt Plant, 1,250 cu. yds. capacity, is not equipped by the manufacturers with any mechanical means of handling asphalt. The asphalt must be bought in steel drums or wooden barrels and put into the melting kettles by hand labor. This usually requires two laborers to keep enough asphalt in the kettles.

In order to dispense with these two men, we installed a Kinney Pump with 2 in. suction and 1½ in. discharge; the pump, run by a 3 H. P. steam engine, was placed on a platform between the two kettles and convenient to the mixer. A concrete tank or cistern was built, as shown in the accompanying sketch, large enough to hold two tank cars of asphalt cement. Steam coils were placed in the bottom of the cistern to melt the asphalt. A 2 in. steam jacketed pipe was placed from the pump to the tank.



A CONTRACTOR'S ASPHALT PLANT LAYOUT.

When tank cars were used, upon the arrival of the car, steam was turned into the coils of the car, and as soon as the asphalt was melted the car was drained by gravity into the tank, thus releasing the car in about twelve hours. When package asphalt was used, the staves or steel container were removed from the asphalt and the whole barrel rolled into the tank. Three men in about two hours time at night would put enough asphalt in the tank for a day's run of the plant. Valves and piping were arranged so that asphalt could be pumped from the storage tank to either kettle or from either kettle to the weighing bucket.

We figure by this arrangement we can eliminate two men and make a material saving in the cost of asphalt by buying it in tank cars instead of in packages.

Experience of the New York Commission of Highways in Doing Its Own Construction Work on Unfinished Contracts

valuable functions of a State Board of Public Works, but the point here emphasized is that public water supplies should be

During 1918 the New York Commission of Highways concentrated their efforts upon the completion of roads already under contract. The department of construction took up the work on 15 cancelled contracts aggregating about 68 miles. Writing of the results of this work in his last annual report, former First Deputy H. Eltinge Breed said:

"The unusual success of the department in doing its own construction work upon these unfinished contracts, despite the interminable coils of legal red tape twined about it, raises the question whether it might not be advantageous for highway departments to be authorized and prepared in emergencies to do their own construction as well as engineering work. As in our own case, plants could be hired or gradually acquired, and contractors engaged as superintendents. The arguments pro and con are lengthy; the idea is advanced now simply because it is in accord with that spirit of the age which is tending to centralize authority and to unify responsibility."

How the Work Was Handled

Procedure on this work is described as follows by E. A. Bonney, Supervising Engineer:

"In carrying on this work a superintendent was procured who, as a first qualification, was a live, responsible contractor; who had not defaulted on any work with this Department; and whose record for integrity and business acumen in prosecuting his own work was unquestioned. He was placed upon a straight salary basis and a rental agreement executed for such plant as was necessary to properly carry on the work. Our plant rental prices are far below the going commercial rates and will stand comparison with rentals paid at any time and place.

"A representative from this department was placed upon the work as engineer and timekeeper, if it were possible for him to do both. On some of the larger contracts two men were needed. Wherever it was possible, the individual laborers, mechanics, teams, etc., were paid by individual check, after signing vouchers and payrolls for the amount due them. Payments of wages was made twice each month and to the lasting credit of the auditor's office, no employes were lost during the summer because of failure to receive their compensation on time.

"The rates for labor varied in different sections of the State from 30 cts. an hour to 45 cts. In no case was the rate paid by us in excess of that paid by individuals in the same section. The labor was generally scarce, hard to procure and inefficient, at least in comparision to five years ago. The laborer knew that he could get work whenever he wanted it and cared less and less about his job as the season wore on. It was a most trying and difficult problem for the men in charge. Nevertheless, as the season progressed, the State force contracts showed a larger average of work per contract than the work carried on by individuals. The rate of progress also exceeded the other contracts. This was partly due to the co-operation which we received from the Federal government in the procurement of cars to carry material, and possibly the preference shown us by the manufacturers of materials and owners of quarries because our credit as a purchaser was unassailable. This was particularly true in the matter of coal.

"The work in general was very satisfactory as to speed and quality. The costs were not excessive although we faced a handicap of comparison at the start because most of the contracts were taken as extremely low figures and the contract prices were far below the cost of present day work."

In closing, I will state that it is my belief that such work should not be carried on as a general practice. It places upon the Department entirely too great an amount of detail and too much personal responsibility upon the engineers and superintendents handling it. It has proved in the last two years that it is possible and feasible as a last resort for a commissioner of highways. It prevents him from having his hands tied by wilfully obstructive tactics of a surety company as evidenced in the past by their bidding in completion work at prices far below cost after which no work would be started; and provides the citizens of our State with relief when ordinary methods of procedure fail. When kept down to a minimum and used only in the extremity, the system has proved its value.

The Design and Construction of Bituminous Macadam Roads and Pavements

By A. W. Dean, Chief Engineer, Massachusetts Highway Commission, Room 212 State House, Boston, Mass.

A bituminous macadam pavement is one having a wearing course of macadam with the interstices filled by a penetration method with a bituminous binder.

Such pavements were built in a rather crude manner in England and France in the early part of the nineteenth century, but were nowhere extensively built until little more than

ten years ago, when the change in vehicular traffic and consequent increased destruction of waterbound macadam pavements made necessary the construction of a surface to withstand the new destructive forces on the roads. In the United States the year 1908 marks the real beginning of this type of pavement, although a few small experiments or attempts were made previously. The first results achieved, while at the time appearing successful, were not durably satisfactory, due to the fact that improper materials and workmanship were used. Further experimental construction and careful observation of results obtained by varying the character of material and method used have resulted in a widespread use of this type of pavement at the present time, and when properly constructed it has proved to be an economical type where the vehicles to be propelled over it are not extremely heavy.

Drainage and Foundations

In the construction of this pavement, as in that of any so-called permanent type, proper drainage and foundations are absolutely essential. Moisture and frost action under the road crust are just as destructive as in the cheapest or most expensive pavements.

If the subsoil is a gravel or suitable sand, no artificial foundation may be necessary, but if of clay or other improper material, a foundation course consisting of stone or coarse gravel should be placed. If of stone, the interstices should be thoroughly filled with gravel to prevent the clay subsoil from gradually working up and filling the voids in the stone, thereby permitting the moisture to permeate and destroy the foundation and pavement during frost action.

The First Course

Upon the properly prepared natural or artificial foundation the first course of broken stone should be spread evenly and to sufficient depth to be of the desired thickness after rolling. No universal rule can be made covering the thickness of this course, as the local conditions vary so extensively. For example, in some localities, the subsoil is of such nature, and the materials available in the immediate vicinity are of such nature, that an artificial foundation of stone 10 ins. or more in depth may be laid and the first course of the pavement need be only about 2 ins. in thickness. This is economical and satisfactory in localities where suitable stone for foundation is plentiful, but stone suitable for the first course of the macadam has to be imported at considerable expense. On the other hand, if the subgrade is a proper one so that artificial foundation is not necessarily used, the first or bottom course of the macadam should be not less than 4 ins. in thickness after rolling, and, if heavy loads are to be sustained, a thickness of 6 ins. is desirable.

The stone in this course should be of uniform and good quality, and should be spread in such manner that there may be no segregation of large or small stone. The stones composing this course may vary in size from ½ in. to 3 ins., in their longest dimensions, provided, however, that the percentage of the small size shall be very small. If the course is 4 ins. or less in thickness, the best results are obtained, however, by using stone varying in size from 1¼ to 2½ ins. The same minimum size is preferable in a 6 in. course, but the maximum size may then be 3 ins.

In laying this course the same methods should be used as in the laying of ordinary waterbound macadam, including thorough compaction by rolling, and securing a uniformly smooth surface. Unlike the first course in waterbound macadam, however, the voids in this first course must be filled with stone dust, fine gravel, or sand, in order to prevent wasting of bitumen by penetration into this course during the construction of the top course. It is essential that the surface of the bottom course be even and without depressions before laying the top course. After the construction of this course is completed, all surplus dust and fine material should be swept off, leaving the upper stones bare to receive the second or bituminous course.

The Second Course

After the completion of the first course as above set forth, the second course is spread at such thickness that it will be 2 ins. thick after rolling, if for medium or light vehicular traffic, or 3 ins. thick if for heavy vehicles in large volume.

It is extremely important that the stone used in this course be of good quality, uniform in character, and so spread that there is no segregation of large or small sized stones. If building for light-weight vehicles only, the stone used may have a French coefficient of wear as low as eight and a hardness value of eight, but for heavy vehicles a better quality of stone should be obtained if possible, using in such case a stone having a French co-efficient of not less than twelve, and preferably even greater, and a correspondingly higher hardness value.

Sizes of Stone

The best and most lasting results are obtained if the sizes of the stone in this course vary from ¾ in. to 2½ ins., with the larger sizes predominating. This has been proven, even though it appears inconsistent to use a 2½ in. stone in a course 2 ins. thick.

Extreme care should be had in the laying and rolling of this course to have it uniform in its component sizes of stone and rolled to a uniform thickness. The rolling should be thorough, in order to reduce the voids and make the surface hard and smooth, although not as thorough as in the case of waterbound macadam roads.

Applying Bituminous Material

After rolling, the bituminous material should be applied at a temperature of 250° to 300°F., with a mechanical distributor that will force the material onto the surface uniformly, such force being equivalent to that obtained under a pressure of 30 lbs. or more to the square inch. The amount of bituminous material used per square yard in this application will vary from 1½ gals. on a 2 in. course to about 2½ gals. on a 3 in. surface. Great care must be had in the distribution of the bitumen to prevent getting too much or too little material in spots or streaks, otherwise "bunches" or depressions, as the fault may cause, will soon develop.

After spreading the bitumen, it should be lightly but completely covered with pea stone (½ in. stone) and thoroughly rolled, using a 15-ton roller, if available, and if the stone is of hard quality, and a somewhat lighter roller if of a poorer quality stone. Success will not be obtained if this course is not thoroughly rolled.

A seal coat of the same quality of bitumen is then applied, using one-half gal. of bitumen to the square yard for this application, then covering again with pea stone and finishing with the heavy roller.

When the bitumen is applied the stone should not be wet, but may be moist, and in all cases must be absolutely clean and free from dust. The bitumen used may be an asphalt or tar product, and as this paper is somewhat limited, the details of specifications for this material are necessarily omitted.

The Bitumen

Whether of asphalt or tar, the bitumen should be properly refined and prepared for use in this type of construction, its properties varying slightly with the climatic condition of the territory in which it is to be used.

In northern climates like that in the New England States and lower Canada, the best and most lasting results appear to be obtained by using an asphalt having a penetration of 90 to 110, as determined by the standard method of testing adopted by the American Society for Testing Materials.

The United States Department of Agriculture has published a bulletin (No. 691), giving specifications somewhat in detail for bituminous materials of different kinds and for different uses, which bulletin is available for distribution. Reference is here made to that pamphlet for more details, but the writer believes from experience and observation that for penetration work in northern climates the asphaltic material

should be a little heavier than that suggested in those specifications.

Where properly built under suitable climatic and traffic conditions, the bituminous macadam pavement is economical both in construction and maintenance. If a hole appears in the surface it should immediately be patched, using a mixture of small stones and hot asphalt or tar. If a general breaking of the top surface appears imminent, it should be given a seal coat of hot asphalt and pea stone before such breaking up occurs.

Rules For Prevention of Unsatisfactory Results

A few condensed rules are here given for the prevention of unsatisfactory results with bituminous macadam:

Be sure that the drainage, subgrade and foundations are suitable.

Have the surface of the bottom course even and without depressions before laying the top course.

Have the larger sizes of broken stone predominate in the top course.

Use dumping platforms or self-spreading wagons for spreading all broken stone.

Use a sufficiently hard bitumen for both penetration and seal coat, as a soft material permits the surface soon to become wavy.

Get all penetration work complete during the spring and summer months. If done in the late fall the penetration is not complete and the pavement is liable to become loose in the following winter.

Patch holes immediately if they appear in the surface.

If tar is used, apply a light seal coat at intervals of two or three years.

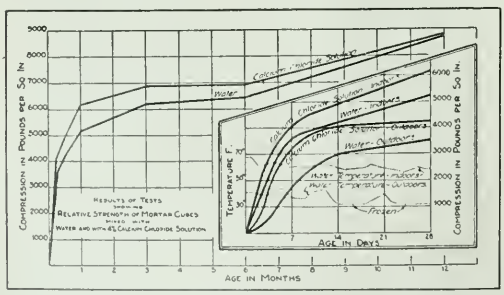
Acknowledgement

The foregoing paper was presented at the Sixth Canadian Good Roads Congress.

Advantages in Use of Calcium Chloride Solution to Hasten the Setting of Cement Concrete

A series of tests were completed in 1918, by the New York Commission of Highways to determine the advantages in the use of calcuim chloride solution to hasten the setting of cement concrete. The results of these tests are described as follows by H. Eltinge Breed, formerly First Deputy Department of Construction in his annual report:

"It has been stated that by use of this solution concrete gun foundations could be put in use three days after construction. The tests made by this department were for the purpose of determining whether the rapid setting would decrease the ultimate strength which the concrete would attain. It is well known that abnormally quick setting cements do not usually make concrete which is as strong ultimately as the slower setting cements.



RESULTS OF TESTS SHOWING RELATIVE STRENGTH OF MORTAR CUBES MIXED WITH WATER AND WITH 4 PER CENT. CALCIUM CHLORIDE SOLUTION.

Laboratory test samples were prepared and tested at ages varying from one day to one year. The results are shown graphically herewith. They indicate that the use of a four per cent solution of calcium chloride as mixing water for cement concrete increases the strength attained at all ages up to one year. Beyond that is still problematical, but what evidence we have indicates certainly no deterioration, and a probable continued, but slower, gain. The maximum increase appears to be about 20 per cent at the age of one month.

The importance of this determination will be appreciated when it is considered that by the use of this solution it will be possible not only for the contractor but also for the public to make use of cement concrete pavements a few days after they have been laid without risk of damage. It will mean the completion of much work in the autumn which has hitherto had to wait over unfinished until spring.

Highway Requirements for Twentieth Century Transportation. with Special Reference to New Jersey Practice

By Wm. G. Thompson, State Highway Engineer, Trenton, New Jersey, in Address to National Highway Traffic Association

So many different factors enter into consideration of this subject that it is difficult to state and classify them in the order of their relative importance. The first factor is traffic—present and future.

Traffic Uncertainties

For what weight and size of vehicle must the highway of tomorrow be constructed? Next comes future volume of traffic, which can not be estimated with any degree of accuracy, since, prior to 1912 no really widespread movement for construction of high-class pavements in the rural or interurban districts was noticeable, further that paving of roads in any particular locality increases not only the number of motor vehicles owned in that locality, but the use of its roads by foreign cars, whose owners are ever seeking new routes for business and pleasure. Therefore, we can hardly venture a prediction as to the increase in volume during the next fifteen years. It would seem, then, that our design can be influenced only by an arbitrary estimate or determination of future needs as to the widths of pavements in order to obviate congestion. The same is true as to thickness or depth of foundation, since there is no precedent to guide design, because no pavement has heretofore been designed to carry a specific loading. Here again enter variables, such as impact at varying speeds and loads and varying sub-foundation conditions.

Specific Data Lacking

The Bureau of Public Roads in Washington is now making tests to determine the extent and effect of impact on pavements. These tests, extensively conducted on each type of modern pavement and covering varying foundation conditions, should prove of great value to the highway engineers of the country.

Lacking specific data, and precedent, highway engineers are now making use of the best types known today, such as Portland cement concrete and brick, stone block and asphaltic concrete on concrete foundation, and hope they will last for 15 or 20 years. Since I am more familiar with conditions in New Jersey, I will outline what is now being done on the state highway system there in an earnest effort to provide for the future traffic, highways which shall be smooth and convenient to motor traffic at all times of the year.

Alignment, Grades and Width.

On all state highways, the graded width or carriageway from gutter to gutter will be not less than 30 ft. In the open country we are going to considerable expense to secure curves not sharper than 6 degrees, and grades not exceeding 5 per cent. All curves sharper than 5 degrees are being super-

elevated or banked, there being a gradual transition from the straightaway to the curved section. This method has already proven its value as an aid to easy riding, since there is no perceptible strain or overturning motion while rounding the curves so treated.

Drainage

Particular attention is being given to sub-foundation drainage, upon the adequacy of which the integrity of the pavement depends in marked degree. It is believed that expense incurred on this factor, before the pavement is laid, is justified because the pavement may be rebuilt or rejuvenated from time to time without entire removal to correct drainage conditions which should have been cared for during the initial construction. On long flat stretches storm sewers are being built with catch basins to carry off surface water which would not flow in flat grade side ditches or gutters.

Pavements

Hard pavements will be not less than 18 ft. wide. In addition there will be 3 ft. stone shoulders on each side, making in effect, 24 ft. pavements. There will then be 3 ft. earth or gravel shoulders, making a total of 30 ft. of carriage or travelled way. On the main, heavily travelled routes are being laid concrete pavements 8 ins. thick at the sides and 10½ ins. thick at the center. On the secondary routes are being laid concrete pavements 6 ins. thick at the sides and 8½ ins. thick at the center. Where asphaltic, brick or stone block pavements are used they will have concrete foundations not less than 6 ins. thick, except that in the more isolated sections, where traffic will not be heavy for many years, asphaltic pavements will be laid upon existing macadam bases, where such exist of proper width and depth. None of the state highways will be paved with macadam or bituminous macadam, or any other material inferior to asphalt or concrete.

A sincere effort is being made to build for the highway traffic demands of tomorrow. In alignment, width, grade and pavement, the view point is that we are building for a long time to come and the best obtainable, within reasonable financial limits, should be had now. In the Engineering News Record for May 8 is found this question: "Why are such revolutionary changes necessary in pavements which have given satisfactory service on heavy traffic city streets heretofore?" It seems to me there are several good reasons for the building of city pavements on interurban and country highways. In the first place, city streets, until the past three years, were never subjected to the test to which they are now, and will hereafter be subjected, and it remains to be proven that present city pavements will stand the new strain. We can all remember when no vehicle using New York streets travelled at a greater speed than four or five miles per hour. Heavy horse-drawn trucks downtown moved three or four miles per hour. Now, motor trucks with the same and heavier loads travel 15 or 20 miles per hour. On rough pavements the impact and destructive forces are, therefore, now many times greater, notwithstanding the change to solid rubber tires. If these things be true in crowded city streets, will they not be more true on country highways, where, when city restrictions as to speed no longer hold, every class of motor vehicle increases its speed to 25 or 30 miles per hour. I am convinced that if speed alone were to be considered, it will be necessary to build stronger pavements on interurban highways than on city streets, especially in New Jersey, where, because of its many industries, the motor trucking between cities is very heavy today. Tomorrow will but bring a greater volume and density.

The drainage factor also requires that heavier pavement foundations be built on interurban highways. City streets are usually paved from curb to curb. They are underlaid by sewers, pipe lines, conduits, etc., all of which conduce to good sub-foundation drainage, while surface water runs to the gutters and is quickly carried away by the sewers. In the country and especially in cuts, there are springs, the menace of which it is difficult to remove. Water from open ditches and hillsides seeps into and under the foundation. In wet weather the foundation is softened. In cold weather, the saturated foundation freezes and expands, heaving the pavement and often breaks the surface. Considering the destructive effect of impact at high speed, and of inadequate drainage, and the relative effect of these two factors on city pavements, it is believed justification exists for building heavier pavements in the country than in the cities.

Bridges

Our state highway bridges are being designed and built for a loading of 20 tons, it being assumed that 75 per cent. of the vehicle load will be on the rear axle. Under bridges spanning the highways, vertical clearance will be not less than 14 ft. from pavement to under side of girder.

Grade Crossings—Railroad

Railroad grade crossings are being eliminated wherever and as rapidly as practicable. In one instance of a section of the state highway now under construction, the relocation of the highway to parallel the railroad will do away with eight grade crossings within four miles; this includes the parallel tracks of two different railway systems.

Signs

A comprehensive system of road signs is being installed to indicate direction, distance, dangerous crossings, curves and grades. These will be substantial, having concrete posts, and the inscriptions so designed and worded as to enable the motorist to proceed with the least inconvenience and loss of time.

Observing the singular lack of markers to enable motorists to proceed through city streets while en route from one city to another, and to reach the trunk highway quickly, we are marking the street corners with a distinctive sign, which will enable tourists to pass from the state highway entering the city, through the widest streets in the most direct manner possible, to the state highway leaving the city. At present there are few corners on through routes in large cities so marked as to expedite movement of through traffic.

In order that there shall be no unpaved sections through small cities and towns on the state highways, the state will pave at its expense through all municipalities having a population under 12,000. With municipalities having a population exceeding 12,000, the state may enter and is now entering into agreement with such cities, by which each shall pay a portion of the cost. In many of the smaller communities the town authorities are paving from the state pavement to the curb. The routes of all state highways are so designated or laid out as to enter the large cities through their widest streets, so through traffic will not have to use the narrow, congested city streets. The county engineers of New Jersey, with the state highway department, have adopted a standard system of marking so all highways under county control will be thoroughly posted in the same manner as the state highways. These facts are cited, simply to show that the coming needs are fully realized, and earnest effort is being made to provide for them.

Present Highway Requirements

Briefly stated, highway requirements for the 20th century transportation as we see them are the following: Ample funds, good alignment with flat curves and low grades; adequate sub-foundation drainage, the widest, strongest, toughest pavements obtainable; where they enter large cities paved widths should be several feet wider than in open country. Bridges designed for at least 20 ton loads, few or no railroad grade crossings; a comprehensive, thorough system of marking for distance, direction, and dangerous conditions; and a system of reasonable and enforced traffic laws which will protect all motorists, yet permit the expeditious movement of traffic.

The state highway commission has published and is now circulating an official map of the state highways, showing all state and county roads, indicating sections of routes under construction, and printed data concerning detours, to enable motorists to avoid most conveniently the construction work. This

map and information will be revised from year to year as the work proceeds, so as to be always up to date.

This paper was supposed to deal with what are considered to be the highway requirements necessary for the 20th century; in setting forth herein what New Jersey is doing, I am but reflecting the ideas of its highway commission, which is trying to foresee the requirements and is building accordingly. It realizes that in many localities the pavements should be wider, but is building the best its finances will permit, confidently believing that the system, when completed along present lines, will prove so satisfactory that the public will provide additional funds for extensions and improvements.

How Albany, N. Y., Saved Over $360,000 in Using Re-Dressed Granite Paving Blocks

By Frank R. Lanagan, City Engineer, Albany, New York

The Problem

The old granite block pavements in Albany, N. Y., have been a veritable gold mine in the extensive repaving operations undertaken by the city. In the era before motor vehicles, most of the streets of any appreciable grade were paved with dimension granite blocks on a 14-in. foundation of block or river sand. Due to cuts, frost action and years of wear, the old granite block pavements became uneven and unsatisfactory for the rapidly growing use of modern motor vehicles and the problem was how to repave or pave practically all the streets in the business section and provide surfaces which would be satisfactory for both horsedrawn and motor vehicles, particularly on the grades.

A Successful Experiment

In 1911 an experiment in repaving was tried on a short narrow street with a grade of about nine per cent. and subject to heavy traffic. The old granite blocks were taken up, cut in half and redressed and paved with grouted joints on a new 6-in. concrete foundation. The resulting surface was uniform, smooth, perhaps a little too smooth to give horses a good foothold, easily kept clean and not noisy from traffic.

As a result of this experiment, it was decided to use similarly the old granite blocks on practically all of the business streets of heavy traffic. There were some exceptions, as for instance, using asphalt on one street on a slight grade that previously had had granite, storing the granite and later using it after cutting and re-dressing on a street that previously had had vitrified block.

The Re-dressed Blocks

The average dimensions of the old granite block were 3½ ins. wide, 7½ ins. deep and 11 ins. long. The specifications for the broken and re-dressed granite required that each old block of sufficient size and quality should be broken and re-dressed to obtain fair, true and approximately rectangular surfaces on the top and sides, the dimensions to be not less than 6 ins. in length, from 3½ to 4½ ins. in width, and not less than 5 nor more than 6 ins. in depth. Due to culls, a small deficiency of blocks resulted from paving equivalent areas. The city, however, supplied blocks to make up the deficiency from its storage pile, the contractor doing the necessary carting and handling. The workmen who did the cutting or breaking and re-dressing of the block became very expert in the number they could prepare in a day. They were paid 1 ct. per new block cut and re-dressed at first, but later the price was increased to 2 cts.

Laying the Re-dressed Blocks

The re-dressed blocks with the new faces up and with end and side joints not exceeding ¾ in. were laid on a 1½ in. sand cushion over a 6-in. foundation of 1-3-6 concrete. The joints were grouted with a 1 to 1 grout. At first pea-stone was used partially to fill a portion of the joints and to hold the blocks in position while paving and ramming were in progress, but it was found that the grout did not penetrate through the pea-stone to the cushion and in consequence under particularly heavy traffic the blocks became loose, so the specifications were modified and the pea-stone omitted.

Grouting

In grouting the joints, it seemed to be practically impossible so to squeegee the surface that the grout would not also cover the top of the pavement. This is to the disadvantage of horses on the grades particularly in bad weather.

On one block, it was necessary to return after the street had been opened to traffic and score the joints with cold

VIEW OF REDRESSED GRANITE BLOCK PAVEMENT ON STATE ST., ALBANY, N. Y.

chisels using power from a portable air-compressor. The city has now, on grades of 6 per cent. or more, adopted the practice of relaying the old granite blocks without breaking and re-dressing, on a minimum sand cushion over a concrete foundation, grouting the joints but raking them before the cement has hardened. This gives a uniform surface perfectly satisfactory for motor vehicles and at the same time affording a good foothold for horses on the worn and rounded surfaces of the old granite.

Cost Data

Following are the quantities and the average prices per square yard for dressed granite blocks and for re-dressed granite block pavements on a 6-in. concrete foundation from 1913 to 1918. The price per square yard for the dressed granite block pavement includes the displacement excavation, the foundation, sand cushion, new blocks, grouting, etc., complete, and the price per square yard for the re-dressed granite block includes everything as above except the blocks, the old granite being taken up, the blocks cut, re-dressed and reused.

	New Dressed Granite Block Pavement		Cut and Re-dressed Granite Blk. Pavement	
	Sq. yds.	Aver. price	Sq. yds.	Aver. price
1913	1,852	$3.55	16,919	$2.29
1914	9,833	3.44	48,220	2.36
1915	12,309	3.22	199,556	2.18
1916	39,404	3.23	44,442	2.09
1917	1,501	3.79	18,199	2.26
1918	27,871	4.33	425	2.62

As may be figured from the above, the saving to the city through having and refusing the old granite blocks, thus avoiding the expense of new dressed granite blocks was over $360,000.

Considerations Affecting the Choice of Road Machinery

By Arthur H. Blanchard, Consulting Highway Engineer, Broadway and 117th St., New York City, in Address to Sixth Canadian Good Roads Congress.

The high wages of unskilled labor in 1917, 1918 and 1919 and the uncertain status of the labor supply of the future has resulted in a thorough analysis of highway construction data to determine economical methods of using road machinery. The trend of wages of unskilled labor was ably covered in the 1919 report of the committee on "Unskilled Supply" of the American Road Builders' Association, wherein it was stated that the average rate per hour in the United States in 1912, was 19 cts; in 1913, 20 cts; in 1914, 20.5 cts; in 1915, 22.5 cts; in 1916, 26 cts.; in 1917, 30 cts.; and in 1918, 39 cts.

Demand for Labor Saving Machinery Increases.

In the opinion of the writer, American highway officials must face high wages for unskilled labor for several years. The basic economic law of supply and demand naturally applies to labor conditions. It is not probable that the war shortage of unskilled labor will be changed over night. It is not logical to expect that unskilled labor, which entered the service will rush back to the pick and shovel after demobilization. Emigration records show that thousands of laborers are leaving America every month. Immigration, the usual source of supply of unskilled labor, is an unknown quantity and agitation in the United States for restricted immigration further complicates the situation. It is not surprising, therefore, that the reconstruction period finds highway officials, engineers and contractors investigating all types of labor saving machinery.

Factors Influencing Selection of Equipment

The selection of equipment for the construction and maintenance of highways should be based upon a consideration of the following factors: (1) character of work; (2) specification requirements covering plant equipment; (3) amount of work; (4) portability of plant; (5) large and small units; (6) ease of manipulation; (7) adaptability to different classes of work; (8) funds available; (9) depreciation of plant; (10) transportation facilities. The practical necessity for the consideration of many of the above factors is self-evident.

Character of Work

In the case of contractors whose work is confined to the construction of sheet asphalt pavements and in the case of a department such as, for instance, that of Wayne County, Michigan, where the highway work consists primarily of grading operations and the construction of cement concrete pavements, the problem is materially simplified. On the other hand where a contractor's work covers the construction of all the various types of roads and pavements used in a municipality, county or state, the selection of the several units of plant equipment should be based upon their adaptability to different classes of work. For example, where cement concrete pavements as well as concrete foundations are to be constructed, in many cases a type of mixer should be purchased which is satisfactory for the construction of pavements, the requirements for which are more specific than in the case of mixers used only on foundation work.

Specification Requirements Covering Plant Equipment

In the modern practice of highway engineering, many specifications include stipulations which must be met by machines and accessories employed. As illustrations might be cited the weight of rollers, pressure limitations in distributors, grouting apparatus, and details of mixers for the manufacture of bituminous concrete.

Amount of Work, Portability of Plant, Large and Small Units

It is evident that a contractor for a department will be justified in the purchasing of an ideal equipment if the work is to be extensive in character. If the work is centralized and large in amount, as in the case of sheet asphalt work, in many municipalities a large, well equipped permanent plant will prove economical. If, on the other hand, the work is large in amount but distributed over considerable area, small portable units will prove more satisfactory, as in the case of mixing plants for the manufacture of bituminous concrete to be laid on provincial highways.

Ease of Manipulation

In cases where contractors are engaged in general highway work and their organization does not include foremen who are specialists in the manipulation of various types of complicated machinery, it is of utmost importance that simplicity of machines and ease of manipulation should be given great weight in the selection of equipment. This is particularly true in connection with various types of machines used in the construction of bituminous surfaces, bituminous macadam and bituminous concrete pavements.

Adaptability to Different Classes of Work.

It is well known that specifications for different classes of work, requiring the same type of machine, call for differences in detail. For grading work, specifications might require rollers weighing from 12 to 15 tons, while in the construction of wearing courses of some types of pavements, a 10 to 12-ton roller is stipulated. A contractor who is handling a small amount of general highway work would, therefore, find it advantageous to purchase a 12-ton roller suitable for both classes of work mentioned above.

Funds Available

Departments and contractors are necessarily forced to consider first cost of equipment, as the funds available may not permit the installation of the most economical and efficient machines. In many cases where such conditions are encountered, it is obvious that it will not be practicable to anticipate that the work can be accomplished with the same degree of rapidity and at the same cost as if more efficient machinery constituted the plant equipment.

Depreciation of Plant Equipment

Depreciation charges on plant equipment should be given careful consideration prior to the purchases of machines and accessories as well as in the consideration of the cost of highway work.

Transportation Facilities

Facilities for the transportation of machinery and materials materially affect the efficiency of the several units of plant equipment. For example, in municipalities and provinces where materials may be transported over highways in good condition, the use of the motor truck will usually be found desirable.

Plant Equipment Suitable for Grading, Quarrying, Construction and Snow Removal

Brief consideration will be given to the plant equipment suitable for grading, quarrying, construction of the several types of roads and pavements, and snow removal. It is also evident that normal conditions usually will be assumed as the basis for suggestion of plant equipment for the various items of highway work enumerated.

Transportation Equipment

Motor trucks and wagons usually will be found a necessary part of the equipment for all classes of highway work. Tractors and trailers are proving of particular value on long haul work where loading and unloading apparatus require motor trucks to remain idle during several hours a day. Industrial railroads have proven efficient equipment on highway work where a large tonnage is to be handled quickly on long hauls.

Grading

Grading operations vary from the scarifying of an old road surface, preparatory to the construction of a new wearing

course, to heavy cut and fill work requiring the moving of thousands of cubic yards of material. It is apparent that only extreme conditions can be mentioned in this discussion as the economics of the utilization of various classes of machines on average grading work would necessitate a comprehensive discussion. For the lightest class of grading mentioned, scarifiers drawn by rollers have proved more economical and efficient than the use of picks in roller wheels or any one of the several types of plows drawn by rollers or tractors. For the heaviest class of grading work, in many instances steam shovels loading into wagons will be found economical. In connection with all grading work except light scarifying, one or more of the following types of machines should form a part of the plant equipment for grading: Road drags, grading and rooter plows, drag, buck and wheel scrapers, elevating graders, and rollers. It should be noted that the utillzation of the elevating grader has not been fully developed by many contractors.

There are on the market many types of steam and gasoline traction engines suitable for hauling grading machinery. For many classes of grading work, their use is more economical than the employment of horses and mules. Essential features which should be based by a contractor for grading work are as follows: (1) sufficient power for hauling the several types of grading machines under the variety of conditions on which it is expected to be used; (2) adequate mechanical strength; (3) simple mechanism enabling it to be easily steered, controlled and otherwise operated; (4) driving wheels of large diameter and of such width as to enable the tractor to operate efficiently on soft ground.

Quarrying

Plant equipment for quarrying depends primarily upon the kind of rock, the required output per day, and the length of time during which the quarry will be worked. Drills and blasting devices are a necessary part of all equipment for rock work. Contractors or departments working the quarry to supply material for a specific highway would use the ordinary portable crushing and screening plant consisting of boiler, engine, jaw crusher, elevator, screen and bins. Small quarries, more or less continuously operated, are generally equipped with the above plant except that in many cases the gyratory crusher proves more economical. Passing to the largest quarries, modern equipment for the economical manufacture of broken stone should consist of steam shovels for removing the rock masses for the quarry face to steel cars. In such quarries the pieces of rock transported to the crusher may vary in size up to masses weighing 7 or 8 tons. The rock should be first crushed in a mammoth jaw crusher from which the rock should be passed through a series of gyratory crushers, jaw crushers and rolling mills and thence to elevators, screens and bins. In some plants of this type washing devices are a necessary part of the equipment in order to produce stone chips free from dust.

Earth Roads

In the construction of earth roads on a large scale, the following equipment has been found to be economically efficient: Elevating grader drawn by horses or by a tractor, scrapers, disc and straight-tooth harrows, road drags, rollers and watering carts. The combinations of the machines mentioned which will be used will depend upon the amount of work, character of the soil and the cross section to which the road is to be built.

Gravel Roads

Spike-tooth harrows, scrapers, road drags, rollers and watering carts constitute the equipment for the construction of gravel roads. Many engineers and contractors have found grooved rollers more satisfactory for this class of work than smooth faced rollers.

Broken Stone Roads

The average equipment consists of harrows, rollers, and watering carts. For many types of construction and kinds of rock, rolling for long periods with 10 or 12-ton rollers has secured a better compaction and economical bond than in cases where 15 and 18-ton rollers have been used for short periods. Some contractors have found automatic screening spreaders a valuable addition to the plant equipment.

Bituminous Surfaces

The equipment required for the construction of bituminous surfaces depends upon the amount and character of the work and the rapidity with which it must be accomplished. For example, the construction of a bituminous surface on a broken stone road will require an equipment of rotary brushes or coarse fiber brooms, bass fiber brooms, in some cases batteries of heating kettles, a distributor to meet specifications and adaptable for the distribution of the kind of bituminous material under conditions stipulated in the specifications, pouring cans, squeegees, and, in some cases, 5 to 10-ton rollers and hand-drawn or horse-drawn automatic stone chip distributors.

Bituminous Macadam Pavements

The equipment will depend primarily upon the specifications and the kind of bituminous material employed. The usual equipment consists of batteries of heating kettles, a distributor, pouring cans, and a roller. The specifications covering certain features of the distributor may be specific, as in the case of the 1918 specifications adopted by the American Society of Municipal Improvements herewith quoted:

"The pressure distributor employed shall be so designated and operated as to distribute the bituminous materials specified uniformly under a pressure of not less than 20 lbs. nor more than 75 lbs. per square inch in the amount and between the limits of temperature specified. It shall be supplied with an accurate stationary thermometer in the tank containing the bituminous material and with an accurate pressure gauge so located as to be easily observed by the engineer while walking beside the distributor. It shall be so operated that, at the termination of each run, the bituminous material will be at once shut off. It shall be so designed that the normal width of application shall be not less than 6 ft. and so that it will be possible on either side of the machine to apply widths of not more than 2 ft. The distributor shall be provided with wheels having tires each of which shall not be less than 18 ins. in width, the allowed maximum pressure per square inch of tire being dependent upon the following relationship between the aforesaid pressure and the diameter of the wheel: For a 2 ft. diameter wheel, 250 lbs. shall be the maximum pressure per linear inch of width of tire per wheel, an additional pressure of 20 lbs. per inch being allowed for each additional 3 ins. in diameter."

Bituminous Concrete Pavements

The type of pavement, amount of work, the specifications and the kind of bituminous material employed materially affect the selection of the plant equipment for this class of work, Batteries of heating kettles and a roller are required for the construction of all types of bituminous concretes. Although the practice of contractors has varied to a considerable extent with reference to the weight and type of roller, many now favor the 10 to 12-ton tandem roller for all classes with the exception of Topeka Bituminous concrete. Plants of many types have been successfully employed in the manufacture of bituminous concretes. Naturally the most economical and efficient work has been accomplished by a plant especially adapted for mixing the type of aggregate used. Generally, on highway work outside of urban districts, the portable plant proves most satisfactory. Dependent upon the plant accessories, the aggregate is measured by volume or weight before being dried or by weight after drying, the latter being preferable. The aggregate is usually dumped into bucket elevators, which discharge into rotary driers. In the best types of plants, the heated aggregate is then raised by bucket elevators and discharged into a small storage bin. As desired, the heated aggregate is drawn from the storage bin and allowed to fall directly into the pug mill mixer or, preferably, first into a weigh-

ing box. The bituminous cement is weighed in scales on the mixing platform and then dumped into the mixer. After thorough mixing, the bituminous concrete is usually discharged into a wagon or truck, which the plant arrangement permits to be placed directly beneath the mixer. For pavements of the type of bitulithic, a rotary screen is a necessary adjunct to the plant. For those types of bituminous concrete in connection with which seal coats are employed, the equipment will necessarily be increased by the addition of hand-drawn distributors, pouring cans, squeegees. and, in many cases, hand-drawn automatic stone chip distributors.

Sheet Asphalt Pavements

The plant equipment necessarily depends upon the amount and location of the work and the specifications. A tandem roller constitutes a part of the equipment for all sheet asphalt work. The mixing plants are of three types, portable, semi-portable, and permanent. A complete plant includes a cold sand elevator, a drier, a hot sand elevator, a hot sand storage bin with screen, an asphalt elevator, a flux tank, melting tank, draw-off tank, a sand measuring box, a dust elevator, bin and measuring box, an asphalt cement bucket and a pug mill mixer.

Cement Concrete Pavements

Variations in economical equipment depend primarily upon the specifications. A beam and bucket cement concrete mixer, forms, screeds, bridges, belts, long handled light rollers, watering carts, pumps and hose usually constitute the equipment for the construction of cement concrete pavements constructed by mixing method.

The essential features of a plant are covered by the following excerpts from a report of a committee of the National Conference on Concrete Road Building: "The concrete mixer should be of the batch type provided with an automatic water tank, traction drive and power loader. Mixers having a boom and bottom-dump bucket of sufficient size to convey one complete batch for placing the mixed concrete are preferred. Where necessary to keep from cutting into the subgrade and to facilitate moving, the wheels of the mixer should be run on suitable planking. The mixer should be provided with a suitable automatic water tank which can be quickly filled and emptied, so that when once determined, the required amount of water can be added to each batch of concrete. The power loader or skip should be of sufficient size to hold all the materials required for the batch.

Wood Block Pavements

For the building of wood block pavements, the equipment should include the necessary apparatus for the construction of the mortar cushion, or a template and hand roller when a sand cushion is employed, a tandem roller weighing from 3 to 5 tons and the necessary distributing apparatus for the application of fillers and the construction of expansion joints.

Brick Pavements

The equipment should include a wood template and hand roller for the construction of the sand cushion, a double metal template for constructing a mortar bed on a green concrete foundation, a tandem roller weighing from 3 to 5 tons, brushes, cement grout boxes or a small mixer if a cement grout filler is employed, or conical pouring cans if bituminous fillers are used for the construction of transverse or longitudinal joints.

Stone Block Pavements

The equipment includes, in some cases, templates and hand rollers for the construction of the sand cushion, tampers and the necessary apparatus for filling the joints.

Snow Removal

Equipment for snow removal is affected by the amount of snow in a storm, the yardage and location of the roads to be cleared. For highways outside of urban districts, road scrapers and horse-drawn and motor plows have been found economical and efficient. In the case of many roads, compaction of the snow being principally required, snow rollers constitute the equipment.

The Advantages of the Cost-Plus-A-Fixed-Fee Contract for Building Construction.

By A. E. Wells, President Wells Brothers Construction Co., 914 Monadnock Bldg., Chicago, Ill.

The last decade has seen the rise and fall of many building contractors, large and small. The cause, in the majority of cases, lies in the fact that the contractor is expected to build not only according to specifications and within the time limit, but to gamble that his cost will come within a fixed contract price notwithstanding the variables such as the forces of nature and the conditions of labor. Therefore, failures are many.

The Old, Gambling Contract.

Most business men will agree that it is not within the province of the contractor to gamble. He is retained as an expert to assemble materials into a finished whole. It is not difficult for an able concern to finance itself for this work but if in addition it must carry insurance for owner that it will perform within a definite contract price, the financing is more difficult.

In competitive bids, the cost of this insurance is paid generally by the low bidder out of profits, or, as frequently happens, out of his capital, for the reason that he is more likely to get the contract as he scales down his allowance for contingencies. A competitive bid which includes a safe allowance for insurance against contingencies was seldom low under pre-war competitive conditions. The inevitable results were the bankruptcy of the contractor and an additional cost to owner or the surety company to complete the unfinished contract.

The Owner's Viewpoint

It is apparent, however, that an owner feels more sure if he is able to know, in advance, closely what a certain project will cost. A careful estimate, made by a reliable contractor and checked by the owner's architect and engineer, is certain to be more satisfactory than a competitive bid in which the result may show only which contractor is willing to take the longest chance against the possibility of costs higher than estimated. A bank, for instance, may issue certain bonds for a power house and if the cost runs above their total, additional financing is necessary. This should be avoided, and yet, why should the contractor be asked to underwrite the accident of greater cost?

War Time Test Proves Merit of Cost-Plus Contracts.

At the Chicago meeting of the Associated General Contractors of America, Nov. 21, 1918, this topic was thoroughly discussed and Brigadier-General R. C. Marshall, Jr., Chief of Construction Division, War Department, U. S. A., pointed out clearly the fault of the usual pre-war basis of contract. He showed the impossibility on recent War Department work of asking for competitive bids, because speed was the essence and detailed plans and specifications were never complete at the time when construction must start. On such work it was therefore out of the question for a contractor to bid on a flat contract price basis. It would have been fair to neither side. There was developed, therefore, a form of contract known as the Cost-plus-a-sliding-scale-fee contract.

General Marshall stated that early in the spring of 1918, the program of work before the Construction Division was so extensive that it seemed advisable to have the merits of this form of contract again passed upon, and a committee of eminent business men unqualifiedly endorsed this form of contract in General Marshall's own words at the convention of general contractors:

"No contractor should be called upon or permitted to undertake the performance of any contract that within the four corners of the paper upon which it appears is, or may be written the financial bankruptcy of the contractor. It is unjust, it is inequitable, it is uneconomic. The great lesson

of this war on the subject of the relationship, between the contractor and the owner is the cost-plus contract. This represents the only equitable basis under which a contractor may perform constructive and economic services for the owner. It is the only form of contract which affords protection to both parties. To me, all the energies, the thought and the experience of this country within its own continental lines during the past year and one-half of this world struggle shall have been in vain unless out of it shall grow, as a permanent institution, solidifying the economic relationship between the contractor and owner, the cost-plus contract."

My Company has built extensively under both forms of contract and our most satisfactory work, both to owner and to ourselves, has been on the cost-plus basis. For such concerns as Montgomery Ward & Co., The William Davies Company, Limited, Toronto, The Robert Simpson Company, Limited, Toronto, and Butler Brothers, Chicago, we have operated on this plan, have been able to start construction work much sooner than would otherwise have been possible and therefore given early occupancy. Almost without exception we have made savings for the owner below the preliminary estimate of cost.

Don't Forget Interest During Construction

The fact that money tied up during construction earns nothing, makes quick construction attractive in practically all fields of building. When we are given the opportunity to work with the owner, architect and engineer at the very inception of plans and to begin foundations as soon as the general contour of the building and equipment are determined upon, we are able to give the owner a service which is impossible under the lump sum price contract, as this requires the long delay necessary for the completion of plans and the taking of competitive bids, all of which may be extremely costly to the owners.

But we do not believe that the cost-plus fixed fee basis of contract is applicable only to work where speed is the first essential. In the years to come it will doubtless prove to be the most equitable basis for all classes of construction and upon that basis our company is now operating. The owner properly reaps the benefit of any saving which may be made below the estimate, thru the combined and co-operative effiort of owner, architect, engineer and contractor.

The major manufacturing operations are conducted upon this plan. The Ingersoll dollar watch is now a thing of the past. While that watch "Made the dollar famous," it now retails for considerably more because of conditions beyond the control of the maker. That watch is now made on a cost-plus fixed fee basis, if you please, for the price is going up with the cost of manufacturing.

In the field of the automobile we do not find manufacturers gambling with a fixed price. From season to season, costs vary and selling prices follow.

That the contractor, supposedly an expert in building matters, should be called upon to absorb the risk entailed in any form of contract other than that based upon cost-plus fixed fee is to me unbusniesslike, unfair and unAmerican.

War conditions furnished the opportunity and the necessity for testing out more generally than ever before this form of cost-plus-fixed-fee contract and results prove that the great majority of the building industry met the test adequately and honorably. Post-war reconstrution conditions will be met to the best advantage to both owner and contractor if the cost-plus-a-fixed-fee contract is generally used.

The Engineer in Politics—How Far Will the American Association of Engineers Go in Politics?

By W. A. Stinchcomb, County Engineer, Cuyahoga County, Cleveland, Ohio, in Address to Annual Convention, American Association of Engineers

Let me make myself clear in the use of the word "politics." I do not refer to it in its partisan sense, but I do most decidedly refer to it in a civic or governmental sense.

The Duty of the Engineer to Enter Politics

To say that the A. A. E. and its members shall not go into politics would be to deny to the country and the local communities within which it has chapters the service of an organization of men who, by natural ability, by education, by training and experience are most capable of serving the public and in directing and educating the voters on questions of public policy, and would deny to its members the fulfillment of their obligations as citizens of this Republic.

Now I know that a natural tendency exists among engineers not to take an active part in politics, but by so doing they evade their full responsibilities as citizens. Will any one say that the engineer's training and experience do not better fit him to solve the problems of government as our civilization becomes more complex, than one trained in any of the other great professions?

Some Political Problems Stated

What are some of these political problems?

In our cities practically all of our public problems are subject to scientific analysis. Is the subject one of developing the physical plan of the city, including the adequacy and location of its highways, the kind and strength of its pavements, the development of its park and recreation facilities, the working out of a proper drainage or the planning of its transportation facilities, either rail or water? Surely the engineer is best qualified to solve such problems. He is now called on for advice in these matters, and in my opinion he should be largely the one to decide.

In matters of public health as influenced by problems of sanitation such as sewage and garbage disposal, water supply and building and housing regulations, he is best qualified.

On questions affecting the control of public utilities such as transportation, electric or gas supply and telephone service, his engineering training best fits him to bargain with the trained mind representing the public utility companies, and to know when the contract has been made that justice is done both the public and the service corporation.

As cities extend further into the realm of municipal ownership of these public utilities, his obligations to serve the public in an executive capacity in directing the management of such work increases and his fitness to serve grows.

Even in the welfare and social problems of the city his analytical training fits him to search out the cause of our social evils and ills—to relieve them rather than apply only palliative and preventive measures.

Will any one say that he is less qualified to organize and direct the ordinary housekeeping affairs of a city because of his training and experience?

The Engineer Should Take Dominant Part in Politics

One of the most difficult and always present problems of all government is that of financing and taxation. It is the constant duty of the engineer in his practice so to design, execute and organize his work that the cost will be as low as possible. All problems of public taxation must go back to a proper appraisal of the property taxed whether that property be in a tangible or intangible form. Here again his experience and training fit him well to serve efficiently.

Our national governmental problems are best solved when the engineering mind influences their solution.

And so in my opinion the engineer should take a dominant part in politics, and this association as an organization should wield a forceful influence in determining the civic and governmental policies—not as a right only, but as an obligation which both the engineer and the association owe to society.

Political Activity Beneficial to the Association

"But," I hear some timid soul say, "what effect will that action have on the engineer and this association?" In my opinion it cannot be anything but beneficial.

This convention has had its attention called to the inadequacy of the salaries paid engineers in public services. Various means will be discussed as to methods by which salaries may be properly and equitably increased. How better can this be done than that the members of this profession shall take an active interest in the political question of their communities?

We have noted the appointment of men neither fitted by education nor training to take charge of departments of public service which really require the services of the trained engineer. We have seen the engineer subordinated to such superiors. He has seemingly been content to let his "light shine under a bushel," and have the accomplishments of his brain and energy appropriated by those to whom they do not rightly belong. By a more active participation in politics these injustices would be removed and credit bestowed where it rightfully belongs.

What Other Professional Men Do

We have seen national organizations of other professions jealously guarding the business interests of the members of their professions. There is the National Bar Association, the various national organizations of the medical fraternity, whose efforts are used not only in maintaining a proper code of ethics in the profession, but in seeing that the members of that profession as a body are not discriminated against by the passage or operation of what they consider to be unjust laws. And so in halls of legislatures their representatives are seen when measures affecting those professions are under discussion—and the professions referred to do not have to do with the public work of the state in any degree compared with that of the engineer.

It has always seemed to me that the engineer himself has been to blame for the position in which he is held by society and for the meagerness of the salaries paid by both public and private corporations for his services. He has been retiring in his nature, content to too large a degree to take his reward from the satisfaction growing out of difficult problems well solved and difficult work well performed.

Engineers Must Speak Up for Themselves

I recognize the fact that there are certain kinds of professional advertising which are distasteful, but I know that you cannot expect to have the public place a proper estimate on the value of a profession unless that profession itself as an organized unit holds it up to a high standard of value. This in a large measure can be accomplished by a proper indulgence by the engineer in the political problems and discussions of the day.

We cannot in a democracy expect to maintain our government for any length of time in advance of the intelligence of the voters. The intelligence of the voter is only expressed through the polls, and is influenced by the kind of political education which the voter receives. In elevating the standard of citizenship the engineer can and should be a leader in his community. To be anything less not only results generally to the disadvantage of the individual but decidedly to the disadvantage of his profession, and is a direct evasion of the responsibilities of citizenship which his training and ability impose upon him.

Therefore, in my opinion the members of this organization and the organization itself should take an active part in politics in the sense in which the word has been used. They and it should become leaders in moulding public opinion in a manner free from partisan political bias.

Three City Engineers Discuss the Movement Calculated to Improve the Employment Conditions of All Engineers in Public Service

To the Editor: With reference to engineers in public service and plans that may be made for bettering their conditions of employment and compensation:

It is a too common idea that an engineer in public service has his position as a result of some kind of "pull" and that he has not necessarily been selected for his position because of fitness for it. Unfortunately, also, there are too many cases existing today where this idea is not far wrong.

This condition can be remedied to some extent by an organization, fostered by engineers, which will make recommendations for the general good of the profession to the appointing powers and having these recommendations based upon the merits in each case. The organization should then stand behind such recommendations. I do not mean a political organization in the general acceptance of the term, but merely an educational organization intended to bring to proper attention the facts in each instance, and backed by sufficient membership to assure these recommendations serious consideration.

Efforts could also be directed toward a campaign for placing executive engineering service under civil service and making it impossible to remove these heads merely because of a change in the political appointing power. Subordinate positions selected from lists passing so-called examinations should be filled by those who can really satisfy the requirements for the position. The writer was recently requested for a list of civil service examination questions for various positions in a municipal engineering force. The list was made up and was not as technical as it should have been. However, the comment on the list was that "the fellows cannot pass that. They would have to have some engineering knowledge." Salaries should be placed at a figure that would not make it desirable for men to leave municipal employ for private employ on account of better compensation for like work. At the same time, the men should do the same amount of work for the corporation that is requested of them by private employers.

I believe that the only way, under existing conditions, that the above results can be in a measure accomplished, is by an organized publicity effort on the part of those familiar with the requirements and duties of various engineering positions, reasonable recommendations as to salaries, etc., and sufficient publicity to make it apparent to the appointing powers that these recommendations are for the best good of the general public. Anything that the American Association of Engineers can do along this line will be a step toward the betterment of the profession.

Very truly yours,
HARRY C. McCLURE.
Commissioner of Engineering and Construction.
Dayton, Ohio, June 9, 1919.

To the Editor: Relative to the movement calculated to improve the employment conditions of all engineers in public service:

This is a subject which I think has given engineers in public service, especially those who are at the head of public service organizations, something to think about, especially during the past seven or eight months. I am frank to confess that this subject has taken about as much of my time during this period as the administration and supervision of the work which we have undertaken and has caused me no little concern.

I am in sympathy with any movement developing the interests of municipal and county engineers or engineers in any particular line of work and I think the American Association of Engineers is doing a great service to the men in the engineering profession. When we begin to discuss the subject of bettering conditions of engineers we do not want to let our minds run in the one channel, that being the increase of compensation. My feeling in this matter has always been that men in the engineering profession should devote a portion of their time to promoting the non-technical interests of the engineers in public service. By this I mean that engineers should take a greater interest in politics as described in the

address of W. H. Stinchcomb at the recent annual convention of the American Association of Engineers (published in this issue of Municipal and County Engineering). In his address Mr. Stinchcomb says, "Let me make myself clear in the use of the word 'politics.' I do not refer to it in its partisan sense, but I do most decidedly refer to it in a civil or a governmental sense." I know there has been little tendency for engineers to take an active part in public affairs but the sooner engineers in public work appreciate the fact that they should be the leaders in questions of public interest so much the sooner will the public begin to appreciate their service and the compensation will come as a natural reward. Therefore, I believe that when engineers become leaders in molding public opinion in a manner free from partisan politics, they reap rewards in the way of better salaries.

Very truly yours,
E. A. ZIESLOFT.
Akron, Ohio, June 9, 1919. City Civil Engineer.

To the Editor: The subject of compensation for civil engineers is a very live one and deserves active attention from the profession, and especially from that division known as municipal engineers.

In the public's mind engineering covers a multiplicity of services which overlap in their functions to such an extent as to be confusing. There is need, therefore, to classify engineering service into several large groups which can be distinguished readily by the nature of the service rendered. In this grouping subsidiary forms of service must be ignored and only the main branches emphasized. Only in this way can the general public get a comprehensive view of the great field of engineering.

The subsidiary functions are matters of concern, not to the public, but to the profession.

The professional standing of engineers with the public is largely the fault of the engineers themselves. We have no quarrel with the public. Too often we have sat back after solving the knotty problems of civilization and the comfort troubles of humanity, content with the feeling of a needed work well done as our reward. This is a peculiar psychology. The two-fisted, red-blooded, he-men that opened the way to civilization, provided the vehicle for its movement, stayed with it while it moved and served it in its final luxury, are now content with the crumbs from the table—the most practical men failing to achieve a practical result to themselves personally.

Perhaps this has been due to a false and silly standard of ethics. Perhaps we have had the false pride that disdains to talk of filthy lucre in the face of the accomplishments wrought, but we can make the public appreciate the profession only by making them pay a commensurate price for the service rendered.

The question is how to make them pay. On that point, I believe that salesmanship of an idea is the true solution and salesmanship in its broadest and most far-reaching effects is dependent upon publicity.

Engineering must be visualized by an intense campaign of education. The great public does not know, except in a hazy, indefinite manner, that from the mapping of the first Indian trail to the erection of the last skyscraper that the engineer has been the genius that has made possible this present civilization.

Every community needs to know how engineering is intimately connected with its very existence. Municipal engineers receive passing thought and sometimes recognition when Pete Smith's sewer is blocked, and his cellar is flooded, or John Jones can't get his flivver up a mud street.

When the public thoroughly understands what engineering means to humanity, I am optimist enough to believe that the idea of adequate compensation will be sold.

This is the permanent way. I can't help but feel that the arbitrary fixing of prices, while it may afford immediate relief, only places the profession in a trades-union class, with the public's criticism of this method of fixing compensation. I believe that the public once convinced will gladly pay the price.

There are ample reasons on the grounds of increased living costs for an increased schedule of compensation immediately, and that should be on a bonus system determined by the percentage rise in cost of living since, say in 1914. That is, if for this month the increased cost above 1914 prices for standard living commodities is 45 per cent. then a bonus of 45 per cent. on this months' salary should be paid the employee. If next month it is 33 per cent, then the bonus will be 33 per cent. of the month's salary. That would solve the present problem for the salaried man and would give time for building the solid foundations of publicity and salesmanship of service on which to erect a permanent schedule.

We need time to classify the profession, define qualifications for each class, get the protection of a proper license law either Federal or State, establish a surveillance of proposed laws affecting the profession, initiate new legislation, and finally to fix the minimum compensation for each service and to ostracise the man who cuts under.

Very truly yours,
E. A. FISHER.
Lakewood, Ohio, June 9, 1919. City Engineer.

How the American Association of Engineers Aided Engineers in St. Louis Municipal Service in Effort to Improve Their Condition

Contributed by an Engineer in Public Service in the City of St. Louis

Very much to the point of the leading editorial in the May issue of "Municipal and County Engineering" is the history of the effort of the Saint Louis City Engineers to improve their condition.

Employes on Efficiency Basis

The City of Saint Louis, in accordance with the Charter of 1914, has adopted an efficiency system for all city employes. Under this system, all grades of city services have been classified, duties defined, and salaries fixed. This classification went into effect in the spring of 1918, and the salaries fixed did not make full allowance for what was then considered high pay on account of the war. At a later date, when the securing of employes in all grades became more difficult, a supplemental ordinance was passed which added to the salaries specified the folowing percentages: Salaries up to and including $100, 15 per cent.; $100 to $150, 10 per cent.; $150 to $175, 5 per cent. Substantially, these percentages are still effective and are in addition to the rates mentioned later.

Effect of War Conditions

During the latter part of 1918 and the spring of 1919, the city lost many of its best engineers and draughtsmen through competition of more highly paid services. It had already contributed a large proportion to the military service, and this second defection very seriously affected both the number and efficiency of the organization.

The efficiency board was not able to keep up any certified list for appointment, and it became necessary for the department and division heads to find the men and induce them to apply for positions, in many cases requesting appointments in a grade higher than that indicated by the duties in order to secure services. About mid-winter the competition of the railroads for engineering services became exceptionally keen. A number of men were lost, and a number of promotions were authorized in order to hold others. It was also found that there was a serious unrest among the men remaining, and that the quality of the work was being further affected. For this reason, the department heads were thoroughly con-

PRESENT AND PROPOSED SALARY SCALES FOR ENGINEERS IN THE SERVICE OF THE CITY OF ST. LOUIS, MO.

Symbol	Duties of position	Present Scale	Proposed Scale	Railroad Scale
	Engineer Group			
PE I	Junior Professional Engineers— Civil, Mechanical, Electrical Junior Professional Engineering Draftsmen— Civil, Mechanical, Electrical, Architectural	90, 100, 110	125, 130, 135, 140, 145	135-170
PE II	Assistant Professional Engineers— Civil, Mechanical, Electrical Assistant Professional Engineering Draftsmen— Civil, Mechanical, Electrical, Architectural	125, 135, 145	150, 160, 170, 180, 190	170-215
PE III	Professional Engineers and Architects— Civil, Mechanical and Electrical Professional Engineering Draftsmen— Civil, Mechanical, Electrical	150, 160, 170, 180, 190	200, 210, 220, 230, 240	220-250
PE IV	Senior Professional Civil Engineers Senior Professional Mechanical Engineers Senior Professional Electrical Engineers Senior Professional Architects	200, 210, 220, 230, 240	250, 260, 270, 280, 290	300
PE V	Chief Professional Civil Engineers Chief Professional Mechanical Engineers Chief Professional Electrical Engineers Chief Professional Architects	275, 285, 295, 300	325, 335, 345, 355, 365	400
PE VI	Division Engineers (Civil, Mechanical, Electrical)	4,000 per annum	5,000 per annum	5,000
	Draftsman Group			
SPD I	Sub Professional— Draftsmen (Beginners) Blue Print Operators	70, 75, 80, 80, 85	80, 85, 90	100-125
SPD II	Sub Professional— Draftsmen (Tracers)	90, 95, 100, 100, 105	100, 105, 110, 115	125-135
SPD III	Sub Professional— Draftsmen	115, 120, 125, 125, 130	125, 130, 135, 140, 145	135-170
	Engineering Assistant Group			
SPEG III	Chief Gauge Reader	No present schedule	110, 115, 120, 125	No Classification
SPEI II	Instrument Men	90, 95, 100, 100, 105	95, 105, 115	100-125
SPER I	Rodmen	70, 75, 80, 80, 85	80, 85, 90	No. Classification
SPES III	Surveyors	115, 125, 135, 145	125, 140, 150	135-170
	Miscellaneous			
V M O	Assessment Ordinance Draftsman	2100, 2220, 2340, 2340, 2560	2100, 2250, 2400, 2550, 2700	230-250
V M R	Right of Way Agent	140, 145, 150	150, 160, 170	210
ISt B III	Chief Inspector of Bituminous Paving Materials	125, 135, 145, 145, 150	175, 185, 195, 205, 215	No. Classification
PCE III	Engineer in Charge Municipal Testing Laboratory	185, 195, 205, 205, 210	200, 210, 220, 230, 240	225
IC III	Superintendent of Construction (all Municipal Buildings) and Maintenance of Streets	150, 160, 170, 185, 200	200, 210, 220, 230, 240	225
I PD II	Designer of Plumbing and Sanitation	150, 160, 170, 175	175, 185, 195, 205, 215	170-250

vinced of the inadequacy of the rates paid for engineering services, and were ready to recommend a general revision.

Under the complications surrounding efficiency service, such a revision was not easy to carry out, and though suggested on several occasions, it appeared in March, 1919, that nothing would be accomplished.

Under the present standardization ordinance governing efficiency services, revision of salary schedules must be recommended to the Board of Aldermen by the Efficiency Board at the time of the passage of the Annual Budget Bill, generally about the second week in April.

The Local Chapter of the A. A. E. Gets Action

During March, members of the Saint Louis Chapter of the American Association of Engineers had canvassed municipal employes to some extent, but it had secured comparatively few members. In talking this over with one of the division heads, it was suggested to the committee that the municipal engineers felt that the A. A. E. was a railroad engineers' organization, and that it had little to offer them. The committee immediately countered by asking whether there was anything they could do, and on learning the details surrounding the standardization and classification of employes, volunteered to take the matter up with the Efficiency Board from the viewpoint of the employe. A conference was arranged, and a committee of railroad engineers spent a whole afternoon outlining conditions of engineering employment to the chairman and chief examiner of the Efficiency Board, and convinced these officials that the city schedule was too low to permit of maintaining a satisfactory organization. The officials informed the committee that they would recommend a revision and proceeded to outline the revision, which the committee felt was insufficient, but which it endorsed, after careful investigation of conditions had made it apparent that greater demands might spell disaster to the whole campaign. The schedule agreed upon affected six grades of engineers, including engineering draughtsmen, three grades of sub-professional draughtsmen, surveyors, instrument men, rodman, and seven special positions. The present scale and the proposed scale are shown in the accompanying tabulation.

They Call on His Honor, the Mayor

A meeting of municipal engineers and draughtsmen was called by the officers of the A. A. E., and a committee of the City Engineers was appointed to act with the officers of the local chapter of the A. A. E., in handling the campaign for revision. This committee called upon the mayor, who advised them that he favored payment of the prevailing scale to all classes of city employes, and that if the Efficiency Board would present a new scale for engineers and draughtsmen, with their recommendation, he would approve it. The matter was then presented to the City Comptroller, and it is understood that that official called into conference a member of the engineering profession who happened to be employed by the city in a consulting capacity, and that this engineer advised the comptroller that with the exception of about three grades, which should be modified somewhat, the demands were absurd, not in line with prevailing salaries, and that he could secure all the men necessary at the existing rates. On the basis of this testimony, it is understood that the comptroller agreed to this minor modification, and announced himself as being entirely and utterly opposed to the revision of the scale as a whole.

Two City Officials, One an Engineer, Oppose Engineers

It is understood that another city official also was opposed to the revision and is supposed to have taken the attitude that "engineers as a body take so little interest in civic and political affairs as to warrant little consideration from the administration." Whatever the personal views of these officials may have been, it developed on April 14th that the Efficiency Board had recommended to the Board of Estimate the revision of salaries previously agreed upon, that the mayor again announced himself as favoring the revision, but the Board of Estimate refused to accept it, and made only the minor changes mentioned above.

Engineers Turn to A. A. E.

Convinced by this occurrence of the necessity for organization, the engineers and draughtsmen and allied employes of the city services immediately applied for admission to the A. A. E., almost in a body. They were organized into a Municipal Section of the Saint Louis chapter. They proceeded to draw a new ordinance providing for the same revision of the engineering scale, with the addition of a few other special positions, and introduced this ordinance into the Board of Aldermen. They presented their proposal to the Associated Engineering Societies of Saint Louis, and after investigation by the joint council of that body, it was unanimously endorsed by the meeting of May 14, thus giving the schedule the backing of 1,200 organized engineers of the city. The city organization has since been further welded together by the admission of the Saint Louis chapter of the A. A. E. into the Associated Engineering Societies of Saint Louis, thus increasing the membership of the associated societies from nine to twelve hundred. The municipal section has appointed a legislative committee, which is organizing the city technical employes, in order to obtain recognition in each ward, and a publicity committee which is attempting to advertise the engineering profession locally.

The ordinance introduced by the municipal section and known as Board Bill No. 56 of the Board of Aldermen, has had its second reading, and is in the ways and means committee of that body. There seems to be little doubt that the engineers have convinced the aldermen of the advisability of action, but the real test will come when the bill again appears before the board of estimate for approval. It will then be seen whether the city officials who formerly voted against it have been convinced of the political importance of the technical employes on the one hand, and of the folly of accepting the views of a single engineer in such matters, when opposed by the unanimous endorsement of the profession.

The Saint Louis question has become more than a local one, in that the Saint Louis schedule was reported to the National Convention of the A. A. E., on May 13th, at Chicago, Illinois, and while criticised by many delegates as setting too low values was eventually endorsed as a satisfactory schedule for municipal services by that body.

Some Broader Aspects of Rain Intensities in Relation to Storm Sewer Design

By Robert E. Horton, Hydraulic Engineer, 57 N. Pine Ave., Albany, N. Y.

(Copyright, 1919, by Robert E. Horton)

Introduction

While the subject of rain intensity in relation to storm sewer design is a highly specialized matter of technique, likely to interest designing engineers more than municipal officials in general, yet there are certain broader aspects of the subject hitherto little considered, which may not only interest engineers, but others as well.

In view of the large number and diversity of rain intensity formulas which have been developed and the differences among them, for apparently similar conditions, and sometimes for the same stations, the writer took up the question of making a general study and comparison of rain intensity formulas and data readily available, with a view to determining what, if any, general relations might be found to exist between rain intensity and the various factors of a meteorologic nature to which it is related, and whether or not any general form or type of rain intensity formula could be developed.

At the request of the editor of Municipal and County Engineering, some of the results of these investigations, and the conclusions thus far reached, are here presented in brief form. It is impossible within the scope of this article to present the details of the studies upon which some of the conclusions have been based. Some details illustrating special methods of analysis of rain intensity data used by the writer, however, will be presented.

The subject of rain intensity has heretofore been considered mainly in relation to local conditions, and the treatment of the subject has been by purely statistical and empirical methods. In this article some effort will be made to trace out the underlying physical and meteorological causes which produce and control the phenomena of excessive rainfall.

Definitions

The terms "rainfall rate" and "rainfall intensity" are often used as equivalent. It would be preferable to limit the use of the word "rate" to cases where the time involved is some well-established unit used in measuring velocity, such as the hour, or day, whereas the word "intensity" may be applied to the amount during any specified time interval. One may speak of a "rainfall rate" of 3 ins. an hour, which is equivalent to an intensity of 0.5 in. in 10 minutes, 1 in. in 20 minutes, etc.

Ordinary curves of excessive rainfall used in storm sewer

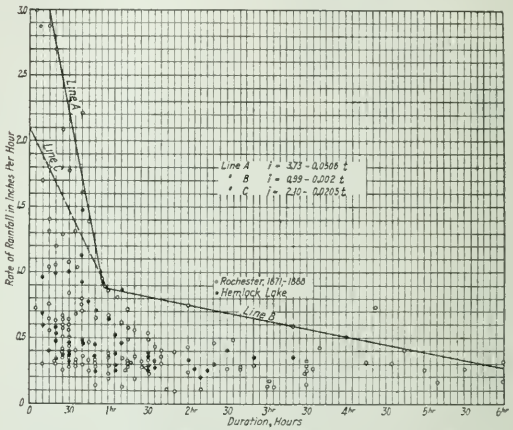

Rate of Rainfall in Inches per Hour
Duration, Hours
Line A
Line B
Line C
Line A I = 373 - 0.0506 t
" B I = 299 - 0.0202 t
" C I = 210 - 0.0205 t
Rochester, 1871-1886
Hemlock Lake

FIG. 1. KUICHLING'S DIAGRAM OF RAIN INTENSITIES AT ROCHESTER, N. Y., 1889.

design express the quantity for a given time interval in terms of the equivalent amount in inches per hour. There are, therefore, really rainfall rate curves, although they are quite generally called rain intensity curves, the amount in inches per hour corresponding to a given intensity and time commonly being expressed by the letter "I." It seems necessary to continue this usage, because it is well established, and because such curves are in reality used to determine the intensity of rainfall for a chosen time interval, which is ordinarily the concentration interval for a proposed storm sewer. In the sense of the words as here used, rate and intensity are identical for a time interval of one hour, while the rate per hour for other time intervals is called the intensity.

The concentration interval is the time required for surface run-off to reach the outlet of a sewer from a chosen location, usually the most remote portion of the drainage area tributary to the sewer.

In order to compare rain intensities in different storms at the same place, or to compare the average or maximum intensities for a given interval at different places in a rational manner, it is desirable that the quantities compared should be equi-frequent intensities.

"Equi-frequent intensities" are those which will occur on the average in the same period of time, or which will be exceeded with an equal frequency or at equal average intervals.

The average interval in which a given rain intensity will be equaled or exceeded may be called the "exceedance interval"

for that rain intensity. It is sometimes convenient to use the term "exceedance frequency," which is equivalent to the reciprocal of the exceedance interval for a given intensity. Similarly the average interval of time in which rain intensities less than a given amount occur may be expressed by the "subceedance interval" or "subceedance frequency."

Notation.—"I" equals the rainfall rate, or, as it is commonly expressed, the intensity in inches per hour for any chosen time interval in minutes.

"P" equals the actual amount of precipitation at a given rate or intensity for a chosen time interval. For time expressed in minutes amount and intensity are connected by the relation

$$P \text{ equals } \frac{It}{60}$$

"T" equals the average exceedance interval in years for any chosen intensity and duration.

N_t equals average annual number of thunderstorms per year.

P_s equals average summer precipitation, May-October inclusive.

a, b and c are constants, and m and n are constant exponents.

The Development of Rain Intensity Formulas

In the earlier studies of this subject no attempt was made to deduce equi-frequent intensities directly. The usual method of deriving rain intensity curves has been to plot all high intensities included within the record as ordinates, and the corresponding time intervals as abscisses. This is illustrated by Fig. 1. Points are numerous in the lower and left-hand portions of the sheet, becoming sparse as the maximum curve is approached.

The curves are arbitrarily located so as to envelop all or most of the plotted points. The curve, Fig. 1, representing maximum intensity might be moved either upward or downward considerably, and still represent rain intensities "that occur only rarely." The position of this curve is in reality determined by relatively few points. The location of the ordinary maximum curve is purely arbitrary, and it may represent intensities which will probably occur twice as frequently in one locality as in another. Hence such a curve without some qualifying factor, dependent on local conditions, cannot be safely applied over broad areas.

If the curve was so located that the probable frequency with which the intensity represented by any portion of it would be exceeded would be about the same, we should apparently have a more rational basis for storm sewer design. Unless the maximum curve used fulfills this requirement, then it is obvious that one portion of a sewer system having its period of concentration, say, 10 minutes, may have its capacity exceeded on an average once in 10 years, while another portion having a concentration interval of 30 minutes may not be flooded oftener than once in 20 years on an average.

The purpose of the design is to make the system homogeneous, all portions being equally efficient.

In 1885 Professor F. E. Nipher, of St. Louis, published (The American Engineer, May, 1885) the results of a study of rain intensities for a period of 47 years at St. Louis. Nipher adopted the formula,

$$2\,T = 6 \text{ or } I = \frac{360}{t} \qquad (1)$$

This is the equation of an equilateral hyperbola.

In 1889 the late Emil Kuichling (Report on Proposed East Side Trunk Sewer for Rochester) developed the following formulas for rain intensities at Rochester, N. Y.:

For periods less than one hour—

$$I = 3.73 - 0.0506\,t \qquad (2)$$

For periods of one to five hours—

$$I = 0.99 - 0.002\,t \qquad (3)$$

For 20 heaviest storms of equal duration the following formula was derived as a probably more accurate substitute for No. 2:

$$I = 2.10 - 0.0205\,t \qquad (4)$$

Kuichling used straight lines to represent the envelope, but states that the envelope for Rochester "might possibly be a hyperbola, but not an equilateral."

The stimulus for this line of study largely arose from Kuichling's work, although most later investigators have adopted a more or less arbitrarily modified hyperbolic intensity curve, following A. N. Talbot.

The accompanying diagram, Fig. 1, shows Kuichling's data and resulting lines and formulas. It will be noted that Kuichling's studies indicate a discontinuity or sudden break in the rain intensity curves for a duration of about one hour. In other words, rain intensities of less than about one hour's duration, according to Kuichling's diagram, follow a different law from that governing the relation of intensity to duration for periods longer than one hour.

In 1891 Professor A. N. Talbot analyzed most of the then existing data of rain intensity for the United States by geographic districts. (The Technograph, University of Illinois, 1891, pp. 103-117.) Talbot derived two equations; the one represents an approximate envelope of all the plotted points and is assumed to give rain intensities which are rarely exceeded. This equation is:

$$I = \frac{360}{t + 30} \qquad (5)$$

Like Kuichling's lines, the derivation of this curve practically disregards all but the highest rain intensities.

Talbot's lower curve is intended to represent rain intensities which are exceeded frequently. His equation is:

$$I = \frac{105}{t + 15} \qquad (6)$$

The corresponding lines on Talbot's diagram, for different geographic sections of the country, are so drawn that most of the plotted points for time intervals exceeding 30 minutes lie above the line. The form of equation adopted by Talbot was apparently assumed arbitrarily. The same type of equation has been adopted by most subsequent investigators.

Talbot was the first to make a general study of the relation of rain intensities to geographic position and mean rainfall. His conclusions were:

(1) That there is no relation between geographic position and rain intensity for short intervals in eastern United States, and

(2) That there is no relation between mean annual rainfall and rain intensity for short intervals.

Both these conclusions are undoubtedly incorrect, a fact which is probably due to the meager and somewhat unsatisfactory character of the data available at the time Talbot's studies were made, and further owing to the fact that in these and most earlier studies of comparative rain intensities equi-frequent intensities were not used.

In the past 25 years a large number of rain intensity formulas have been published in this country. Metcalf & Eddy (American Sewerage Practice, Vol. 1, p. 230) give 30 such formulas. These and many others are derived, for the most part, with relation to some single location or station.

Meyer (Elements of Hydrology) gives 35 such formulas, derived with reference to geographic location and for different exceedance intervals. A few investigators have adopted the type of equation used by Nipher, which may be written in its most general form—

$$I = \frac{K}{\frac{n}{t}} \qquad (7)$$

Some have adopted the form of expression

$$I = \frac{\frac{n}{}}{b + t^{\frac{1}{n}}} \qquad (8)$$

with an exponent n having a value other than unity. A few have adopted more complex algebraic expressions, but the majority, following Talbot, have adopted equations of the type

$$I = \frac{a}{b+t} \qquad (9)$$

which is identical with formula (8) with exponent n equaling unity.

The type of formula used by Kuichling may be written in the general form—

$$I = \frac{a}{t^n - b} \qquad (10)$$

To this list may be added, for purposes of further discussion, the type of formula

$$I = \frac{a\,(1-e^{Kt})}{Kt} \qquad (11)$$

where e is the base of Napierian logarithms.

A comparison of formulas derived by different authorities for the same station or locality shows that there are often wide differences in the results for the same time interval. Sometimes different formulas agree for certain time intervals and are discordant for other time intervals. Formulas of the type of No. 7 give an infinite rain intensity for zero time. Formulas of the types 8 to 11, inclusive, all give a finite maximum intensity for zero time. In formulas 7, 8, 9 and 11 the intensity approaches zero as a limit as the time increases, while in formula 10 the intensity becomes zero for some definite finite time.

Formulas 7 and 9 each contain two arbitrary constants and can each be made to pass through two selected points on the intensity curve. In addition, formula (9) passes through the point a/b for t=0. Formulas of the type (8) contain three arbitrary constants and can be made to pass through three chosen points on the intensity curve, in addition to intersecting the axis of Y at the point a/b for t=0.

Assuming that a rain intensity curve has been plotted from observed data and that it is desired to find an equation for the curve, using a 2 constant formula, quite a different result may be obtained if the points selected for determining the constants, and through which the curve must pass, are those corresponding to 5 and 25 minutes, for example, as compared with the results obtained if the points selected correspond to time intervals of say 10 to 60 minutes.

In general, much closer agreement with the experimental curve may be obtained by the use of a 3 constant formula. The derivation of such a formula is, however, as a rule, relatively laborious, since one of the constants must usually be determined by trial, whereas in the 2 constant formula both of the constants can be calculated directly from two pairs of values of the variables.

All the types of formulas given, except (11) have been adopted in a purely empirical manner without regard to the question whether or not there are underlying physical conditions which make the use of one type of formula more rational than the other.

If, as may be the case, and as suggested by Kuichling, the average relation of high rain intensities to time for short durations follows a different law from that for longer durations, then the determination of this law, and of the best and most rational formula to represent the experimental data in accordance therewith, is a matter of great importance in connection with storm sewer design.

Before giving further study to the subject of the most rational type of rain intensity formula, it is proper to discuss at some length the physical and meteorological processes underlying the causation of high rain intensities.

Causes of Excessive Rain Intensities

The predominating cause of rain, especially in such storms as produce the high rain intensities for short intervals, which are involved in storm sewer design, is the dynamic cooling of an ascending air current. Consider a mass of warm, moist air near the earth surface; if it ascends to a higher level in the atmosphere from any cause, it will expand and cool in accordance with the well-known gas laws, owing to the reduction in barometric pressure at increased elevations. When the ascending air mass is cooled to the dew point, vapor condensation will take place and will continue as the air ascends higher. The mass of condensation increases with increased initial vapor content; and is greater in general the higher the mass of air ascends.

High initial vapor content can, in general, only exist in warm air, hence relatively high temperature is a usual condition precedent to rains of high intensities. The ascent of a mass of air may be brought about by three principal methods:

(1) The upward deflection of a moist air current blowing against a mountain slope.

(2) The ascent of moist, warm air which forms a part of the normal mechanism of circulation in a cyclonic storm.

(3) The ascent of masses of moist warm air as a result of convection.

The last is the general cause of thunderstorms, although they may also occur in conjunction with cyclonic storms, whether a thunderstorm occurs as a local phenomenon in connection with a general cyclonic rain or not. The characteristics of the rain which convection produces are generally so distinct from those of rain occurring under other conditions that the two should be considered separately in studies of rain intensity.

Nearly all high rain intensities occur in the summer. This is not altogether due to temperature, per se, for aside from thunderstorms, in which, as will be shown, most high rain intensities occur, there is a marked difference between summer and winter cyclonic storms, the causes of which are not fully explained. Rains occurring in summer cyclonic storms, excluding thunderstorms, are, on the average, of shorter duration and higher intensity than in storms occurring during the winter months.

Relation of Thunderstorms to Excessive Rain Intensities

Nearly all problems in urban and suburban storm sewer design involve rain intensities of less than one hour's duration, and probably the majority involve rain intensities of 5 to 30 minutes' duration.

TABLE I—SHOWING LOCATION, ELEVATION, AVERAGE NUMBER OF THUNDERSTORMS PER YEAR, AND THE PERCENTAGE OF INSTANCES OF EXCESSIVE PRECIPITATION ASSOCIATED WITH THUNDERSTORMS, FOR A FEW SELECTED STATIONS. (W. H. ALEXANDER.)

Stations	Elevation (Feet Above Sea Level)	Average No. Per Year	Pct. Excessive Rains in Thunderstorms
Atlanta, Ga.	1,174	62.6	95
Bismarck, N. Dak.	1,674	28.5	100
Boston, Mass.	125	18.0	66
Chicago, Ill.	595	40.0	94
Cleveland, Ohio	762	38.4	94
Denver, Colo.	5,272	46.7	100
Galveston, Texas	69	48.1	81
Jacksonville, Fla.	43	79.5	73
New Orleans, La.	51	74.4	87
New York, N. Y.	314	28.4	66
Portland, Ore.	57	5.4	(1)
St. Louis, Mo.	567	52.6	91
San Francisco, Cal.	155	0.8	(1)
Santa Fe, N. Mex.	7,013	73.2	100
Tampa, Fla.	67	94.4	84
Washington, D. C.	112	39.2	87

(1) Excessive precipitation practically unknown at this station; but few thunderstorms and those of a mild form.

The data in Table I furnish a basis for the comparison of rain intensities with mean precipitation and thunderstorm frequency and are here used for that purpose only. Those desiring to consult the original data or the 35 formulas derived therefrom by Meyer will find them in excellent form in Meyer's book, Elements of Hydrology.

Let N_t equal mean number of thunderstorms per year.

T_e equal Exceedance interval in years.

t equal time in minutes.

a and b are constants; a_1 and b_1 are the values of a and b for one year exceedance frequency.

m and n are exponents.

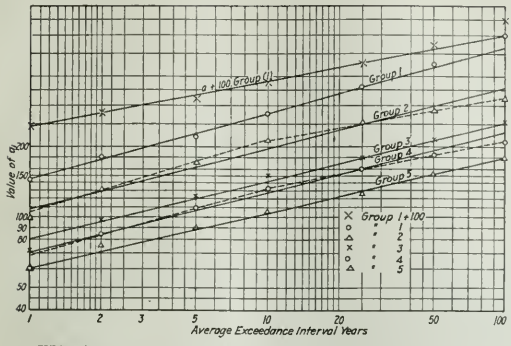


FIG. 2. VALUES OF a IN MEYER'S FORMULAS IN TERMS OF EXCEEDANCE FREQUENCY AND a_1

Then using the ordinary base formula:

$$i = \frac{a}{b + t}$$

An effort has been made to express the constants a and b in terms of thunderstorm frequency and to evaluate a frequency relation in terms of T_e which may be incorporated in the same general formula.

Plotting Meyer's values of a for a given group in terms of exceedance frequency, Fig. 2 has been obtained. While there are some variations, the values of a can be expressed for all the groups by straight logarithmic lines of nearly equal slope, having the equation

$$a = a_1 T^m$$

where a_1 is the value of a for one year exceedance frequency. The slope of the lines is not constant, but increases slowly as a_1 increases, indicating that m is a function of whatever causes affect a_1, including probably thunderstorm frequency. This will be evaluated later on.

A similar diagram was prepared (Fig. 3) showing the relation of Meyer's values of b to the exceedance interval for the different groups. Here again logarithmic straight lines having slopes varying with b_1 fairly represent the data, so that the equation for b may be written—

$$b = b_1 T^n$$

where n is yet to be evaluated.

The values of a_1, b_1 and of the exponents m and n, indicated by Figs. 2 and 3, were then tabulated in conjunction with the mean annual number of thunderstorms at stations included in each group as follows:

Group	N_t	a_1	m	b_1	n
1	67.3	145	0.28	22.6	0.20
2	48.9	108	0.27	19.0	0.12
3	41.6	78	0.26	15.0	0.11
4	30.8	71	0.25	15.5	0.08
5	28.5	61	0.236	12.0	0.04

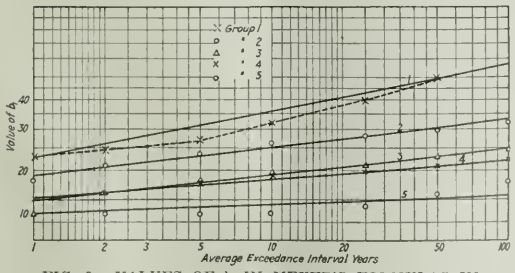


FIG. 3. VALUES OF b IN MEYER'S FORMULAS IN TERMS OF EXCEEDANCE FREQUENCY AND b_1

The mean annual number of thunderstorms, N_t, was deduced from tables by William H. Alexander in the Monthly Weather Review, July, 1915, and are means for the ten-year period, 1904-1913.

Plotting these data in terms of N_t as independent variable, Fig. 3 is obtained. The relations of the coefficients a_1, b_1 and exponents m and n to thunderstorm frequency are all quite consistent, and may be represented by the straight line relations given on Fig. 4. The general rain intensity formula may now be written

$$i = \frac{a_1 T^m}{b_1 T^n + t}$$

The values of a_1, b_1, m and n, and their relations for various values of N_t are given in Table II.

TABLE II—CONSTANTS, MEYER-HORTON FORMULA

N_t	a_1	b_1	a_1/b_1	$a_1/b_1/Nt$	m	n
0	0	7.5	0	:0	.220	—.057
10.0	22	9.8	2.24	.229	.229	—.019
20.0	43	12.0	3.58	.179	.238	.019
30.0	65	14.3	4.56	.152	.247	.057
40.0	86	16.5	5.21	.130	.256	.095
50.0	107.5	18.8	5.72	.114	.265	.133
60.0	129.0	21.1	6.12	.102	.274	.171
70.0	150.5	23.3	6.96	.092	.283	.209
80.0	172.0	25.6	6.72	.084	.292	.297
90.0	193.5	27.8	6.96	.077	.301	.285
100.0	215.0	30.1	7.16	.072	.310	.323

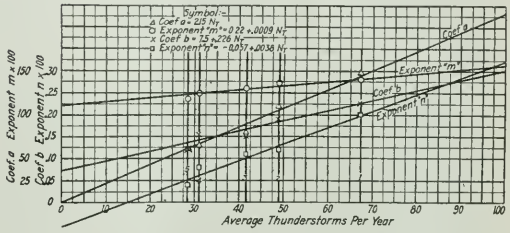


FIG. 4. RELATION OF THUNDERSTORM FREQUENCY TO COEFFICIENTS IN GENERALIZED FORMULA FOR RAIN INTENSITY. BASED ON MEYER'S FORMULAS.

This formula not only replaces the 35 special formulas on which it is based, but may be used for other or intermediate exceedance intervals, and for other stations than those included in Meyer's groups, provided the thunderstorm frequency is known. From the accompanying map, Fig. 5, the mean thunderstorm frequency for most localities in the United States can be determined.

To compare the results given by the general formula with the original data and formulas, take the case of group 4, with ten-year exceedance frequencies:

Here $N_t = 30.8$. Then $a_1 = 66.2$.

$m = .248$ $b_1 = 14.46$ $n = 0.06$

$$i = \frac{66.2 \times 10^{0.248}}{14.46 \times 10^{0.06} + t} = \frac{117.2}{16.63 + t}$$

Meyer's formula for this group is:

$$i = \frac{132}{19 + t}$$

The results by the two formulas compare as follows:

t =	5	10	15	30	45	60	80	100	120
Meyer's	5.52	4.56	3.88	2.70	2.06	1.67	1.33	1.11	0.95
Meyer-Horton	5.43	4.40	3.39	2.53	1.90	1.55	1.21	1.01	0.86
Original data	5.40	4.56	3.60	2.48		1.57	1.08	0.96	

The agreement of the general formula with the original data in this case happens, on the whole, to be rather better than for the single special formula.

It will be noted that the constants in the general formula can all be expressed as functions of a_1—this facilitates the use

of the formula for the extension of a short record, since a, can be fairly determined from a much shorter record than is required to determine the more infrequent intensities.

It is not to be understood that use should be made of thunderstorm frequency data alone as a basis of rain intensity studies, where better data are available. The determination of the coefficients in a rain intensity formula from even a relatively short record with the recording rain gages are preferable. If this is not available, thunderstorm data may be used, but it is better to use an average of the data for several stations subject to similar conditions, in order to eliminate the

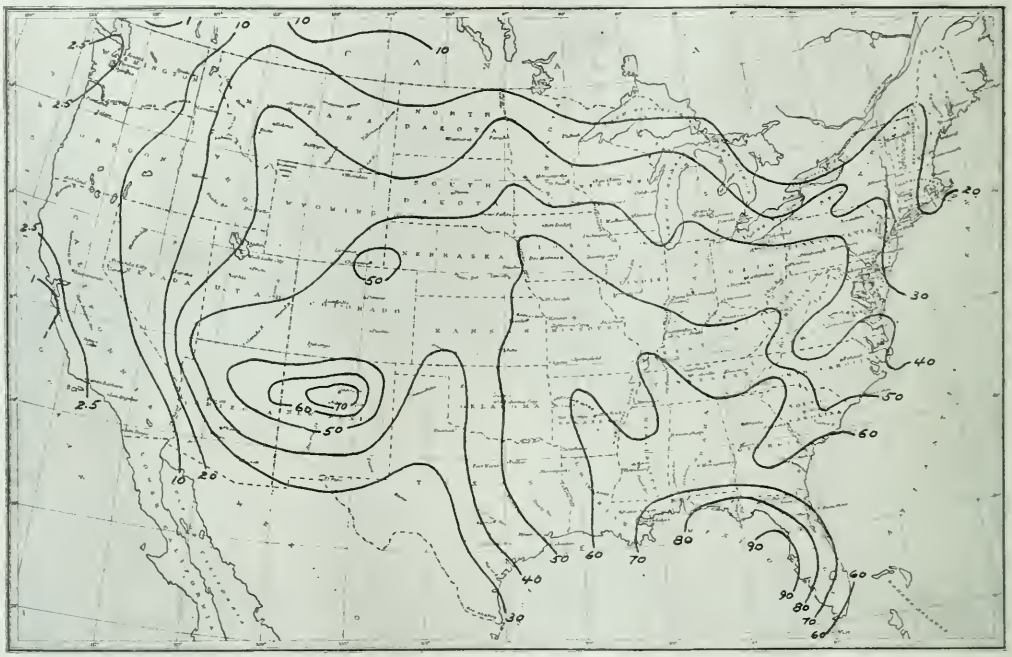


FIG. 5. MEAN ANNUAL THUNDERSTORMS TO WHICH RAIN INTENSITIES ARE CLOSELY CORRELATED.

effect of personal equation in any single thunderstorm record. It is customary to record as thunderstorm days all days on which thunder is distinctly heard, whether rain occurs or not; furthermore, there may be two or more distinct thunderstorms on a single day. It would probably furnish better data for correlation with rain intensity if thunderstorm records were kept in such a manner as to show the total number of occurrences of thunder in conjunction with rainfall at the recording station, counting each distinct thunder shower separately.

It seems probable that the relation between thunderstorm frequency and rain intensity is closer and more definite than the existing thunderstorm statistics reveal.

(To be Concluded in the July Number.)

Concrete in Roads, Bridges and Culverts

By H. Eltinge Breed, Consulting Engineer, 507 Fifth Ave., New York City

Concrete pavement is composed of cement and fine and coarse aggregate, with the admixture of water. Fine aggregate is sand, crushed slag or rock, consisting of hard durable particles smaller than ¼ in. in size, free from organic impurities, carrying not over 5 per cent. of silt or loam, and of such gradation as will give equal or greater compressive strength than the standard Ottawa sand, when tested in like manner using the same cement.

Coarse aggregate is crushed rock or pebbles, consisting of tough, hard particles free from dust and of such size as will pass a 3 in. circular ring and be retained in a ⅜ in. circular ring.

The success or failure of the pavement depends on quality, sizing and proportioning of the materials and the placing and curing of the concrete.

Testing of the Fine Aggregate

First in importance are the materials used; they determine the quality of the pavement. The fine aggregate should be tested for:

1. Organic Impurities.
2. Gradation (sieve analysis).
3. Mortar strength.
4. Volume of silt or loam.

I shall give only the field tests, as these are the most useful and can be readily made by the inspector to determine that the material being used measures up to that approved by the laboratory tests.

Organic Impurities

1. Organic impurities are detected as follows:

"Fill a 12 oz. graduated prescription bottle to the 4½ oz. mark with the sand to be tested. Add a 3 per cent. solution of sodium hydroxide until the volume of the sand and solution, after shaking, amounts to 7 oz. Shake thoroughly and let stand over night. Observe the color of the clear supernatant liquid." If it is colorless, or has a bright yellow color, any organic impurities contained are harmless. If it shows a darker colored solution, the sand should be rejected and accepted only after full laboratory test, a description of which can be found in Part I of the 1917 Proceedings of the American Society for Testing Materials, pages 327-333.

Gradation

2. Gradation tests for sand (sieve analysis). Field Test-

TABLE I—RESULTS OF IMPACT TESTS ON 6 IN. CONCRETE CUBES

Coarse Aggregate	Fine Aggregate	Mix	No. Tests	Grams loss per Test	Average Loss	Remarks
Trap	Sand, Niagara	1-1½-3	3	*150-110		*Small
				105- 95	103	stone area
Trap	Sand, Cowbay	1-1½-3	4	110-120	110	omitted
				110-100		
Trap	Sand, Albany	1-1½-3	4	140-100	122	
				125-125		
Trap	Sand, Long Island	1-1½-3	2	120-135	127	Group (1)
Trap	Sand, Marlboro	1-1½-3	2	130-135	132	103-165
Trap	Tailings, Graphite	1-1½-3	2	155-135	145	
Trap	Sand, Booneville	1-1½-3	4	165-130	149	
				165-135		
Trap	Tailings Iron Ore	1-1½-3	5	*200-155		*Excess
				165-155	164	grout
				165-180		omitted
Trap	Sand, Cowbay	1-2-4	2	150-150	150	
Trap	Sand, Albany	1-2-4	3	180-160		Group (2)
				185-225*	175	150-175
Trap	Sand, Marlboro	1-2-4	2	180-170	175	*Small
Syenite	Sand, Booneville	1-1½-3	8	150-145		stone area
				150-140	141	Excess
				145-125		grout
				*185-130		omitted
Syenite	Sand, Booneville	1-2-4	4	180-205	186	Group (3)
				180-180		141-186
Buffalo Limestone	Sand, Niagara	1-1½-3	5	150-120		*Small
				155-125		stone area
				135	137	omitted
Limestone	Sand, Cattaraugus	1-1½-3	5	155-160		Group (4)
Limestone				140-125	148	137-170
				160-200*		*Excess
Buffalo Limestone	Sand, Booneville	1-1½-3	4	180-160	171	grout
				185-160		omitted

ers are made which have the ¼ in., the 20 and the 50 sieves. By the use of these it can be determined whether the material comes within the limits of the specification.

Mortar Strength

3. Mortar strength test must be made in the laboratory, on account of the necessity of a testing machine to determine the compressive strength. However, a test for set can be made in the field by mixing the sand with cement and forming a pat with thin edges. By breaking the edges after 24 to 48 hours, the engineer can determine how the material sets.

Silt or Loam

4. Volume of silt or loam is determined by adding an excess of water to a given quantity of sand in a glass graduate. The whole is well agitated and allowed to stand until the loam and silt has settled on top, when their percentage may be measured.

The Coarse Aggregate

The coarse aggregate cannot be tested in the field. Field determination of these materials can be made only for voids. Visual inspection should, of course, detect soft material and dirty aggregates. Such inspection should be made constantly, to know that the material is running uniform and of quality equal to the original sample. When we realize that nature never has two deposits alike, the importance of these tests in securing good work will be readily appreciated.

For laboratory test of coarse aggregates, the most valuable is the Deval abrasion test. It is in general use and has been standardized. How accurate it is in determining the suitability of coarse aggregate for concrete remains to be seen. Certain it is, however, that this test indicates the difference between poor and good stone; and taken in conjunction with the impact test, which I will describe later, it is the best means we yet have of determining the suitability of stone for concrete roads.

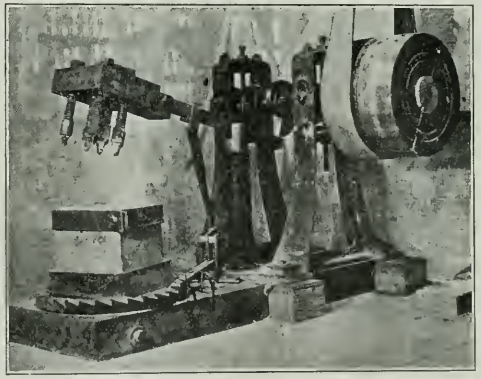
The tests for pebbles, by some called gravel, with the Deval machine have been unsatisfactory, because certain pebbles much inferior in service to trap and syenite rock, show less loss when tested than do these standard materials. In 1915, in our New York State Highway Department Laboratory, we modified the Deval stone abrasion machine, by substituting a slotted cylinder for the closed cylinder. The slots allow the fines to escape, so that there is no protective cushion of dust to keep the pebbles from wear. For four years we have found that this machine has given slag and pebbles a truer rating in accordance with the service test, though often at variance with the showing of the standard cylinder.

After testing the aggregates, we make tests of the concrete they compose for two purposes: first, to determine its wear; second, to determine its strength.

Testing Wearing Qualities of Concrete—Impact Tests

By far the most valuable test to determine the wear resisting values of various aggregates used in concrete roads, is a machine which generates impact stresses, closely paralleling those set up by traffic. In general the machine consists of an arm which is raised by a cam and falls freely, striking the concrete cube. At the head of the arm are placed nine hitting points, armored with non-slip horse calks, each point and its shaft being held in place by a spring giving ½ in. play to compensate for any irregularity or unequal wear during test in the surface of the sample. The effective weight of the head is 29 lbs., and the blows are delivered at the rate of 100 per minute. The sample used is a 6 in. cube or cylinder placed upon a table which is revolved by a dog attachment, so that the blows of the calks strike in 9 concentric circles ¼ in. apart. To date, several hundred tests have been run with this machine, of which the results given in Table I are representative.

The results in Table I indicate that generally the average loss increases as the mortar strength of the sand decreases. An average loss for each test shows that there is greater



IMPACT MACHINE USED IN MAKING IMPACT TESTS BY THE NEW YORK STATE HIGHWAY DEPARTMENT.

strength in the 1-1 1½-3 mix than in the 1-2-4 mix. It is interesting to note that syenite with the French coefficient of 12.5 shows approximately an equal loss under this test to Buffalo limestone with a French coefficient of 7.9. On the basis of the Deval Test, the limestone is inferior for road purposes to the syenite, but service conditions indicate that the Buffalo limestone and many other limestones with a French coefficient of 7 and better are very satisfactory in service. Full results of these impact tests I have for anyone with sufficient leisure and energy to peruse them. In general six conclusions from them seem justifiable:

Conclusions from Impact Tests

1. Crushed stone concrete resists impact better than gravel concrete.

2. Large sized material is more durable than the small sizes.

3. Toughness is a very important factor in aggregate that is subjected to impact.

4. The fine and coarse aggregate must both be good if we are to get the most from the pavement.

5. Coarse grained sand mortar resists impact better than a mortar made with finer grained sand.

6. No relation has as yet been observed between compressive strength and resistance to impact.

In the test to indicate strength concrete from a batch is made up on the road into 6 in. cubes or 6 by 12 in. cylinders from every 500 cu. yds. or less of material. They are cured for 21 days in moist sand and then shipped into the laboratory and tested at 28 days. The following is a record of four years' work done under my direction:

Years.	Mix.	Coarse Aggregate	No. of Cubes.	Average Compression per Sq. Inch.
1915-16.....	1:1½:3	Stone	1684	3590
1917-18.....	1:1½:3	Gravel	221	2950

It will be noted that a total of 1,905 tests were made and that with the exception of the gravel they are well over 3,000 lbs. per square inch. When any individual test shows below 3,000 lbs. we immediately made a thorough investigation to determine the cause. While this would occur too late to correct the given piece of work, it had a good moral effect on the contractor, and wholesome rivalry was inspired among the engineers to have a high test value for their work. The figures given above represent actual tests from the laying of something over 400 miles of 16-ft. concrete pavements of 6 ins. average thickness.

Next in time, but of equal importance to the choice of materials, is the method of application. Upon this depends the strength of the pavement.

Proportioning Materials

The mix should be proportioned in such a manner as to give the greatest density. For the general run of materials and the strength necessary, the 1:1½:3 mix most nearly meets all requirements. By varying slightly the fine and coarse aggregates as indicated by the field tests for voids, the greatest density is obtained. The coarse aggregate should consist of well-graded particles from ⅜ to 3 ins. in size.

Mixing Materials

Mixing should be thorough and of at least one minute duration; however, many specifications require a minute and a half. Whatever the requirement, there is just one sure way to get the full time called for; that is by use of the batch meter. It eliminates all argument with the inspector. It is fairer to the contractor, for it puts them all on the same basis. The water used must be clean and free from oil, acid, alkali, or organic matter. An excess of water impairs the strength of the concrete. Only enough should be used to make the concrete workable. Professor Abrams says that his experiments show that one pint more water than necessary to produce a plastic concrete reduces the strength to the same extent in a one-bag batch as though it had been robbed of 2 or 3 lbs. of cement. Bulletin No. 1, entitled "Design of Concrete Mixtures," by Duff A. Abrams, Lewis Institute, Chicago.

Placing and Finishing Concrete

There are two methods of finishing concrete after it has been placed upon the sub-grade. One is by the use of a machine finisher; the other, which is still more generally used, by hand. The machine type of finishing is proving more and more satisfactory. It gives a uniform, smooth finished result, lessens the amount of labor behind the mixer—a decided advantage in the present labor shortage—and by permitting a stiffer mix insures a stronger concrete. By hand, the finishing is done in various ways. The one that gives the best results is by use of a steel shod strikeboard to level and tamp the concrete. This should be followed by a light roller to take off the excess water and compact the concrete. In some cases this is all the finishing that is done. Greater smoothness may be secured, however, through the use of two belts, which are drawn backward and forward across the pavement with a slightly diagonal motion in moving ahead.

Curing the Concrete

On this depends the final set and durability of the pavement; soon after the use of the final belt the surface should be protected by an awning of canvas to prevent rapid evaporation. There are two methods of curing, that of the earth covering, with subsequent sprinklings to keep the earth moist, and that of ponding. Both of these methods can be put in operation as soon as the concrete has hardened sufficiently to stand the earth cover or the dams for the pond. With the earth cover at least 2 ins. of earth should be put upon the pavement; for the ponding, a depth of 2 ins. of water should be carried. If the temperature is running below 50 deg. Fahrenheit, the covering can be omitted and the concrete sprinkled two or three times a day. Traffic should be kept off the pavement for at least 14 days, though the cover can be removed after 10 days of ordinary weather. During cold weather, opening to traffic should be still further deferred unless calcium chloride is used to accelerate the set of the concrete.

Bridges and Culverts

All that I have said so far of concrete for roads applies equally to concrete for bridges and culverts, with the exception of such obvious details of curing and finishing as must be familiar to every one. Worthy of special emphasis here, however, is the concrete pipe culvert, because many road builders do not yet seem fully aware of its value. The laying of culverts is almost the first piece of work to be done on a job. To have to wait for the arrival of sand and stone to mix concrete often means loss of time and labor that would be conserved if the contractor had his concrete pipe culvert delivered direct from the manufacturer all ready to put in. Then the rest of the work could proceed independently and to greater advantage. The head walls of the culvert can, of course, be built on at any time.

All that has preceded might stand as part of a primer on concrete road building. It is trite. I have ventured to bore you with the repetition of it only because every failure I have ever seen in concrete pavement work has been directly traceable to some neglect of these first principles.

Now, taking for granted the skill and care essential to the success of our pavement, let us jump from the Primer to the Last Chapter of a treatise on engineering. Consider very briefly Economy of Construction.

Economy of Construction.

There are three general methods of building concrete roads.

1. The delivery of the materials on the sub-grade.
2. The delivery of batches direct to the mixer.
3. The manufacture of materials at a central mixing plant.

The first method (materials on the sub-grade) has the advantage as a rule of lower plant charges, but it requires more labor and involves a loss of from five to ten per cent. of the materials used, plus the necessity of re-shaping the sub-grade. The second method (delivery of batches direct to the mixer) has the advantage of saving the loss of materials on the sub-grade and eliminating the extra grading cost; it lessens the number of laborers needed and insures the delivery of materials, when industrial track is used, at times of soft sub-grade and inclement weather. The third method (the central mixing plant) is most economical of all. It saves time and labor through the stationary mixer and the once-made sub-grade. Its chief disadvantage, the segregation of materials in transit, may be obviated by the use of a dry mix and a finishing machine.

If the materials are placed upon the sub-grade, great care should be taken that the piles or winrows of material are of such size and so placed as to require little handling to get them to the mixer. I have known poor placing to increase the manipulation cost one-third.

Where local stone is being manufactured, screenings can be used in some cases for the fine aggregate. Thus we save what generally is a waste product. However, before permitting their use, thorough tests should be made of their fixtures. I have had tests made of commercial stone screenings showing

all the way from 95 to 240% of the compression strength of Ottawa Sand.

A thorough examination of the site of the work and its surrounding territory will often disclose good available local materials. One may fall here between two evils—a too cursory or inexperienced examiner who finds nothing where there is much; or a too zealous discoverer who ardently insists that what he finds is good, whether or no. The people for this work are those with sound training in geology and mineralogy. They will save the state many thousands of dollars that might be lost either through the consideration of poor materials through needless transportation charges.

In another way hitherto neglected, can the State save large sums in building its concrete roads. We all know that by the use of well-graded aggregates in making concrete the necessary amount of cement, its most costly factor, is diminished. In other words, the finer stones fill up the interstices that would otherwise absorb cement and sand. Or, using the same amount of cement and sand, and the well graded stone, you can get an increase over the ungraded stone of from five to ten per cent. in bulk. Shrewd contractors have been quick to take advantage of this, in spite of the fact that some states, like New York, have written their specifications for a graded aggregate. I believe the states would save large sums of money and secure *much* better work by buying *all* the materials for the concrete used in road work.

I will say, with a careful attention to adjectives, that built with due care for first principles and close observance of practical economies, the concrete road will yield generally satisfactory results at comparatively low cost.

Acknowledgment

The foregoing is from a paper presented at the recent Sixth Canadian Good Roads Congress.

Location of Subsurface Pipe Lines to Conserve Street Pavements

By Harry M. Adams, Assistant Engineer, 3219 Parkside Place, Borough of the Bronx, New York City.

Each year as the underground congestion grows worse from the accumulation of pipes that past decades have dumped into our streets, the problem of the maintenance of our pavements becomes even more difficult.

In the downtown business section of New York City we have a network of pipes of various sizes and purposes, many laid without plan or record, so today no one can say just what lies beneath the surface. This labyrinth contains many useless and abandoned mains and services, which complicates the making of ordinary repairs and causes endless confusion.

On account of this apparent official negligence, we find our streets in a state of perpetual upheaval resulting in ever-mounting maintenance cost, increasing inconvenience and menace to our health.

Begin Right, Now, in Unpaved Areas

We can hardly hope to bring order out of chaos at this late day, but when we consider that in the greater city most of our streets are as yet unpaved, and vast areas are even undeveloped, there may still be time to render a valuable service to future generations by profiting by the errors of the past.

The life of a pavement, other things being equal, is in inverse proportion to the number of openings made in it. It would seem then that our policy must be so to plan future streets, that the number of structures laid beneath their pavements be reduced to a minimum, and that those installed be placed with the basic idea of avoiding duplication and conserving space.

Sewers and House Connections

Let us consider what structures are required in the average street. First the sewer. It is advisable to run the sewer in the middle of the street, making house connections wherever necessary. This of course involves the opening of the street, but when once made, the connections seldom require further attention. This practice can hardly be changed unless the sewer in question is part of a lateral system in a wide street. In this case there is good reason to lay two sewers, one on each side near the curb. Connections to spurs can then be made without disturbing the pavement. Some cities require that all house connections be laid to the curb at the time the sewer is constructed.

Water Mains and Services

Next, water mains. These are generally cast-iron pipes with lead joints and are laid somewhere in the roadway. They commonly fail through the lead working loose in the joints because of the vibrating loads passing over them. A vast amount of water is wasted and pavement destroyed through leakage. A leak may exist without any apparent surface indications, and the escaping water following along the pipe down the grade of the street, undermines the pavements until an arch is formed, which sooner or later, under the weight of a heavy load, crashes down, often destroying large areas of pavement.

Service connections to houses are generally lead pipe, which, being of pliable materials, are easily injured and in cold weather frequently freeze.

Gas Mains

Gas mains laid in a similar manner lose volumes of gas through leakage. This poisonous substance enters sewers, subways and other structures, often causing disastrous explosions. When the odor of gas is detected, test holes are dug. Numerous openings may be made and much pavement mutilated before the leak is finally located, as the escaping gas, traveling underneath the impervious surface, seeps through where there is least resistance.

Electrolysis

Service pipes, commonly of wrought iron, corrode easily, and in winter give much trouble when they become "trapped." Being of small bore and laid in shallow trenches, they often pick up stray electric currents in their course across a street. These, being carried to the main, cause electrolysis, which is "hasty consumption" of iron.

Electrical wires and cables are placed in tile or concrete ducts, and splicings and repairs are made in manholes. The distributing lines for local service are of wrought iron or fiber pipe. Subsidiary connections to houses are made from these through handholes or service boxes built somewhere in the street. These house connections frequently run diagonally across under the pavement, and, not being at right angles to the street, are not easily relocated in case of trouble.

Besides these, there are pneumatic tubes, steam pipes, refrigerating mains and others, in some of our streets, but as these are not common in the newer sections, they will not be considered except in a general way.

Placing Gas Mains Under Sidewalks

The majority of street openings, however, are made to install or repair water and gas mains and services, the latter accounting for two-thirds of all openings. Let us consider the advantages to be gained by placing these under the sidewalk.

The mains could be laid without tearing up expensive pavement. The objection might here be raised that sidewalk pavement would be destroyed. This is true, but not all sidewalks are paved to their full width, and the cost of restoring sidewalk pavement, which is of light material, would be much less than that in the driveway.

They would last longer, being removed from the heavy vibrating loads of the driveway. Street traffic would be unimpeded. Water and gas waste would be quickly reduced and leaks soon discovered. Joints could be recalked without disturbing pavement.

Service connections would be entirely eliminated from the roadway. This is indeed important when we remember that most street openings are made on their account. Being short, they would be properly graded, preventing trapping and freezing. Leaks would be correspondingly reduced and readily found. Much material and labor would be saved. Danger from electrolysis would be minimized.

Duplicate System of Mains

This plan calls for a duplicate system of mains, one on either side of the street, and it may be argued that it involves waste and extravagance. The reverse of this, however, is true. On streets of a width of 80 ft. or more the dual system is already in use. Smaller mains may be used; they would last longer and need less repairing. No street pavement would be disturbed in laying connections or repairing them. *There is an actual saving of labor and material,* as the total length of main and services in a built-up street is greater than would be the total for two mains and services placed under the sidewalks.

Electrical distributing lines should be laid in shallow trenches just outside the curb, with service boxes built on them in front of premises to be supplied with service. Connections from these boxes to the house may be made without disturbing the pavement. The space underneath the roadway should be reserved for the large feed mains, trunk duct lines and sewer.

One Office Should Control All Subsurface Structures

The success of any plan to preserve our pavements depends primarily upon efficient administration and full co-operation of the various bureaus concerned. One office should be responsible for the proper installation of all subsurface structures from the issuing of the permit or franchise to the repaving of the street.

Every application for a franchise or permit to install a structure should be carefully scrutinized. Specific locations should be assigned with a view to avoiding duplication, conserving space and saving pavement.

All mains for local service should be placed under the sidewalk. Field notes should be kept and an accurate record filed of all subsurface structures as actually installed.

Blasting a Ditch Through a Swamp

A ditch was recently blasted through a heavily timbered swamp on the farm of F. M. Gaines, near Dothan, Ala. The ditch is 750 ft. long and averages 7 ft. wide and from 3 to 5 ft. deep according to grade. It was cut through a bay and gum swamp covered with water and a great many logs littered the surface and were submerged throughout its course. There were also many cypress, pine, bay and gum stumps, also many small saplings in the line. None of the logs, stumps, or small growth were removed by hand.

The ditch was blasted with 40 per cent. ammonia dynamite. Holes were punched in the earth 30 ins. apart and 2½ to 4½ ft. deep depending upon the desired grade. The shallow holes were loaded with a half to three-quarters of a pound of dynamite and the deeper holes with from a pound to a pound and a half of the explosive. No tamping was necessary as water filled the holes. An electric blasting cap was inserted in each charge and the charges connected together in series by means of the cap wires. As a No. 3 blasting machine was used to fire the charges, it was necessary to do the work in 30 hole sections because that is the capacity of the blasting machine used.

Where stumps, logs and trees were encountered in the line of the ditch, oblique holes were punched so as to get the charges under the stumps or logs and heavier charges were used than where it was merely necessary to blast earth. With that exception, the work was done the same way where these obstructions were encountered as in places where only the earth had to be blasted.

The total cost of the ditch including labor was $105 or 30 cts. per lineal yard. Mr. Gaines had been trying for some time to secure laborers to dig the ditch but failed for reasons well known to all who have been endeavoring recently to employ men for hard disagreeable tasks.

May Sets New Record in Road Work

During May the Secretary of Agriculture approved project statements for 124 Federal aid projects, involving the improvement of 750.87 miles of road at a total estimated cost of $15,120,771 and on which Federal aid in the amount of $6,382,-081.28 was requested. This represents the largest number of project statements approved during any month since the passage of the Federal Aid Road Act.

During the month there were executed by the Secretary and the several state highway departments 81 project agreements, involving the improvement of 667.71 miles of road at a total estimated cost of $7,992,867.25 and on which $3,570,087.22 Federal aid was requested and set aside in the treasury. In addition, agreements to cover 59 other projects were placed in process of execution during the month.

Up to and including May 31, 1919, project statements for 1,188 projects had been approved. The 1,188 projects involve 11,350.10 miles of road, a total estimated cost of $108,295,329.15 and a total of $43,076,176.63 Federal aid. On the same date 617 project agreements had been executed, involving 5,291.86 miles of road, at a total estimated cost of $47,426,749.49, of which $19,521,259.27 was from Federal funds.

Using Explosives in Removing Old Walls

If it is a vertical wall or abutment, probably the best way to crumble it is to drill a vertical line of holes from top to bottom, spacing the holes 3 ft. apart and 3 ft. from the edge of the free side of the wall. The depth of these holes should be equal to three-quarters the thickness of the wall and a safe, yet efficient charge would be from one-third to one-half cartridge of 40 per cent. ammonia 1¼x8 in. dynamite loaded in each hole. Each hole should contain an electric blasting cap and the wires of these should be connected in series and fired by means of a blasting machine. In this manner the wall can be broken in sections.

Another method applicable when the wall is in the open and not adjacent to damageable property, is to drill a row of holes along the bottom of the wall about 2 ft. from the ground and in depth equal to three-quarters the thickness. Holes should be drilled with a slight dip. A charge of one-half to three-quarters of a cartridge of 40 per cent. ammonia dynamite 1¼x8 in. should be loaded per hole and as many holes as desired fired at one time, unless in close quarters, when it would be best to fire two or three holes at a time. One row of holes so situated would be sufficient for a wall up to 12 ft. high and from 3 to 6 ft. thick. If higher than this, it might be best to shoot the wall in two sections, or use vertical rows of holes or load heavier charges per hole.

Brick walls crumble more easily than concrete, and do not require as heavy charges per hole, and holes can be spaced farther apart.

An old brick wall built many years ago, about 10 feet high 4 ft. thick and 20 ft. long, was entirely demolished by placing a row of horizontal holes 2 ft. from the ground, 3 ft. apart and 3 ft. deep. In each hole was loaded one-half cartridge of ammonia 30 per cent., 1¼x8 in., and six holes fired at one time by means of a blasting machine.

Vanguard of fleet of 38 Liberty Trucks passing through Oakville, Delaware County, Ind., in August, 1918, over Tarvia Road built in 1916. Note perfect condition of road after two years of hard service.

Every Community should have roads like these—

HERE is the story of how Delaware County, Indiana, got good roads, as told by the County Surveyor. Every one interested in good roads should read it.

"Our first Tarvia road was built in 1914. Between 1914 and 1918 we constructed sixteen streets and roads, with a total area of about 2,880,000 square feet.

"Some of these are main streets in the city of Muncie, others are main roads subject to heavy traffic, while others replaced low-lying gravel roads that used to wash-out at every overflow of the river.

"Every Tarvia road and street in Delaware County has given uniform satisfaction. No repairs have been necessary.

"Our so-called 'hard' roads, built of brick or concrete are often claimed as permanent construction, but we have in this county brick roads and streets built less than a decade ago that are almost impassable and must soon be rebuilt. New material will be required because the old brick cannot be used again.

"On the other hand, when a Tarvia road wears, a little stone is added, Tarvia is applied, and the road is as good as, or better than, new.

"With proper maintenance, our Tarvia roads will last ten to twenty years. The cost of maintenance will be small and the entire road can be rebuilt at less than half the cost of a brick pavement.

"Considering the various types of road from a purely financial standpoint, one does not need to be skilled in higher mathematics to arrive at the correct answer." (Signed) S. Horace Weber,
County Surveyor.

Tarvia is a coal-tar preparation for use in constructing new macadam roads or repairing old ones. It reinforces the road surface and makes it not only mudless and dustless, but also water-proof, frost-proof and automobile-proof. A few Tarvia Roads in any community will add to property values and reduce taxes.

Illustrated Tarvia Booklet free on request.

Tarvia

Preserves Roads—Prevents Dust

Special Service Department

This company has a corps of trained engineers and chemists who have given years of study to modern road problems. The advice of these men may be had for the asking by any one interested. If you will write to the nearest office regarding road problems and conditions in your vicinity, the matter will have prompt attention.

THE BARRETT COMPANY, Limited:
New York, Cleveland, Birmingham, Seattle, Youngstown, Chicago, Cincinnati, Kansas City, Peoria, Toledo, Montreal, Philadelphia, Pittsburgh, Minneapolis, Atlanta, Columbus, Toronto, Duluth, Richmond, Winnipeg, Milwaukee, Latrobe, Vancouver, Dallas, Bangor, Bethlehem, St. John, N.B., Boston, Detroit, Nashville, Washington, Elizabeth, Buffalo, Halifax, N.S., St. Louis, New Orleans, Salt Lake City, Johnstown, Baltimore, Lebanon, Sydney, N.S.

The Barrett Company

Frederick H. Newell Elected President of American Association of Engineers

F. H. Newell, head of the Civil Engineering Department at the University of Illinois, was elected president of the American Association of Engineers at the annual convention held in Chicago in May. He is widely known as a public-spirited engineer. He has done much for engineering and for engineers. He has been called "father of the U. S. Reclamation Service," of which he was first chief engineer (1902-07) and director (1907-14).

He has had a most active part in all of the reform movements in the engineering profession in the last few years, from the organization meeting of the American Association of Engineers in Chicago in the fall of 1914 to the conference for promoting the Department of Public Works called by Engineering Council late in April of this year. He has served as president of the committee on engineering co-operation from its organization in Buffalo in 1915 to the present time. He was one of the founders of the Washington Engineering Society and served as its president. He is a member of the American Society of Civil Engineers, American Society of Mechanical Engineers, Western Society of Engineers and was one of the original members of Engineering Council.

Mr. Newell graduated in 1885 at the Massachusetts Institute of Technology and after field experience in Colorado and other states was appointed on Oct. 2, 1888, as Assistant Hydraulic Engineer of the U. S. Geological Survey. He actively

FREDERICK H. NEWELL, President AMERICAN ASSOCIATION OF ENGINEERS.

assisted in the preparation and public presentation of various congressional bills, one of which by the personal efforts of President Roosevelt became the Reclamation Act when signed by the latter on June 17, 1902. Immediately after that date Mr. Newell was apopinted Chief Engineer, under Charles D. Walcott, then Director of the U. S. Geological Survey.

During the next few years the organization of the Reclamation Service was completed and plans outlined for extensive work in each of the western arid states, work being initiated on most of these. In 1907 the Reclamation Service was organized as a separate bureau of the Department of the Interior, with Mr. Newell as director.

Speaking of the work of Mr. Newell, Theodore Roosevelt said: "For fourteen years I have followed at first-hand the work of Mr. Frederick H. Newell. I speak from my personal knowledge when I say that he was most loyal and disinterested. He is a public servant of whom it is the bald and literal truth to say, that by his services he has made all good American citizens his debtors."

Mr. Newell has written quite extensively on the problems of development and use of the resources of the country, his principal books being upon irrigation, the public lands and related subjects, notably The Public Lands and their Water Supply.

Personal Items

M. W. Watson was appointed State Highway Engineer of Kansas, to fill the vacancy caused by the resignation of W. S. Gearhart. Mr. Watson has been acting in the capacity of State Highway Engineer since July 15, 1918, when Mr. Gearhart resigned to enter the army.

Mr. Watson is a graduate civil engineer of the Ohio University. He has practiced engineering in connection with coal mining, railroad work and municipal work in Southeastern Ohio, has served in a civilian branch of the United States Army Engineers in connection with the improvement of the Ohio River. Previous to entering the service of the Kansas Highway Commission, Mr. Watson served for five years with the Illinois State Highway Department, from which employment he resigned to accept the position of road engineer with the Kansas Highway Commission, when it was created in the Spring of 1917. He served in the position of road engineer from 1917 until his appointment of acting State Engineer. Mr. Watson is an associate member of the American Society of Civil Engineers, and a member of the Kansas Engineering Society.

J. W. Howard, C. E., E. M. has finished serving in the Ordnance Department of the army and has resumed the practice of his profession as consulting engineer on roads and pavements, with testing laboratories in Newark, N. J., and office at No. 1 Broadway, New York.

Obituary

Captain Henry B. Sauerman, who was one of the organizers of the first company of army engineers in the state of Illinois, died at his home in Chicago on May 20. Captain Sauerman was born at Crown Point, Ind., April 7, 1879, and came to Chicago when a young man. After obtaining his education at Chicago technical schools and the Michigan Military Academy, Orchard Lake, Mich., he entered the employ of Fairbanks-Morse & Co., where he remained for 11 years, first as chief draughtsman and later as contracting engineer. In 1911 he joined his brother, John A. Sauerman, in organizing the firm of Sauerman Bros., engineers and manufacturers. When the original Company A, Corps of Engineers, I. N. G., was formed on Aug. 1, 1911, he enlisted for three years as a private, being elected captain on July 30, 1912, and remaining in command of the company until poor health compelled his retirement at the end of his period of enlistment. From Company A grew the 108th Regiment of Engineers, which has just returned after giving valiant account of itself on the fighting front in France and Flanders. Captain Sauerman was a member of the American Society of Civil Engineers, Western Society of Engineers and Chicago Engineers Club. In 1918 he was awarded the Octave Chanute Medal by the Western Society of Engineers for his paper "Fortification," which was prepared for a meeting of the society in 1916 and later published as a handbook for army engineers. His booklet entitled: "Highways and Railways for the Defense of Our Nation," recently published, which is an extract from a paper written by him in October, 1916, has been accorded very high praise and is in great demand at this time. On this subject he was among the pioneers.

WATER WORKS SECTION

Advantages of Combined Operation of Water and Electric Utilities and Selling Electric Current for Private Use in Springfield, Ill.

By Willis J. Spaulding, Commissioner of Public Property, Springfield, Ill.

After the experience of the past ten years in the operation of the water works and electric plant in Springfield, Illinois, and observation of many other similar enterprises, I feel warranted in stating the two following propositions as being of general application, subject to exceptions, of course, due to unusual conditions:

First, if a city is generating electric current for lighting its streets, it cannot afford to turn the commercial field over to a private company. Second, where steam is the motive power, if the city owns both water works and electric plant, either they should be combined (the pumping station and electric generating station) or the pumping should be done electrically so as to avoid maintaining two steam boiler plants.

Commercial Light and Power.

As to the first proposition, commercial light and power was being supplied in Springfield by a private corporation their rates being such as are commonly charged in cities of its size (60,000): The city's rates including power users and all other classes of consumers average 35% to 40% less than the rates of the private company.

Our lighting rates are 6 cts. for the first 30 K. W. H. used in one month, and 3 cts. for all over. Power rates 1 ct. per K. W. H. plus a service charge of $100 per K. W. H. for the first 10 K. W. of active connected load and 50 cts. per K. W. for all over. Cooking rates 2.2 cts. All rates subject to a discount of 10% for prompt payment.

The city plant has acquired about 25% of the commercial business and could have it all if it were not for the legal difficulties in the way of financing the enterprise. If the city plant was supplying all the commercial business at the present rates there would be left in the pockets of light and power users approximately $150,000 a year while at the same time the plant would be earning a surplus of at least $100,000 annually.

Advantages of Combined Water and Electric Plants

As to the second proposition there are many economies to be gained in operating one plant as against two. In our case, after shutting down the old electric plant and consolidating it with the water works, the tons of coal used for operating both utilities was almost exactly what it has been for operating the electric alone. This was largely due to the substitution of condensing turbines for reciprocating engines exhausting in atmosphere.

We found the same crew of men which were required for operating the pumping station alone, was sufficient to operate both utilities. This gain, however, was offset to some extent because of the fact that it was necessary to maintain an electric substation which was not required when the plants were operated separately. After allowing for this offset we still had a saving of $5,000.

The year ending Feb. 28, 1915, which was the last year the two utilities were operated separately, the total operating expense was $104,694. The first year after consolidation it was $88,805, showing a saving of $16,889. This saving, however, does not reflect the full advantage gained because during the year after consolidation the combined plant not only supplied all the electric current for street lighting and other public uses as it had the year previous but also produced additional current for private use which brought additional revenue of over $20,000. Making allowance for this additional output, I think it would be conservative to say that the total saving amounted to not less than $20,000 per annum.

In relation to city government attention is generally centered on taxes. This is partly due to the natural tendency of those seeking office to call attention to alleged extravagance of the officeholders whom they seek to displace, and on account of this constant exaggeration I think it is fair to say that the average citizen has a very distorted view as to waste incident to the discharge of public functions.

In contrast with the assumed extravagance of public administration, it might be well to reflect that municipally owned and operated water works and electric plants almost universally supply much more service for the money collected than do private companies under similar conditions, which are assumed (often erroneously) to be very efficient. The relative importance of public utility charges from the standpoint of the city government is overlooked. The city of Springfield would, I take it, furnish a fair example in this regard.

Swallowing a Camel

During the present fiscal year our city government will expend from money received from the citizens as taxes and licenses, a total of about $425,000. During the same period the residents of this same city will have paid out for public services suplied by those public utilities which are privately owned (omitting telephone and telegraph) $1,500,000 or nearly four times the amount levied and collected by the city government. These utilities include street railway, gas, electric light and power, and heat, each of which furnishes to the people living in the city, services which are as much public in their nature, and just as necessary to the welfare of each resident as are our public libraries, paving, sewerage, fire and police protection, etc. When we split hairs over our tax rate and overlook this larger item, are we not "straining at a gnat and swallowing a camel?"

Earnings

The total gross earnings of the combined water and light plants for the fiscal year ending Feb. 28, 1919, amounted to $217,238.87; the total operating expenses $124,941.11 leaving net earnings $92,297.76.

After making deductions of $25,200 for "depreciation" to make good the estimated wear or deterioration of the property during the year, a surplus remains of $67,097.76.

The figures presented separately are as follows:

Water Department

Gross income	$140,093.09
Operating expense	75,734.49
Net revenue	$ 64,358.60
Depreciation	20,040.00
Surplus	$ 44,318.60

The city pays nothing for water for public uses although all services are metered where practicable to account for the water used and to prevent waste.

There were in service at the beginning of the fiscal year

Printed as insert to Municipal and County Engineering, Chicago, Ill., June, 1919.

868 fire hydrants. Charging these to the city at $40 a year, would amount to a total of $34,720, which is a fair estimate of the value of free service. This item is entirely omitted in the above figures, and if included would increase our surplus to over $79,000.

Light and Power Department

Gross income	$ 77,145.78
Operating expense (including item of $3,385.00 rent to water department on equipment used jointly	49,206.62
Net revenue	$ 27,939.16
Depreciation	5,160.00
Surplus	$ 22,779.16

The water, light and power department follows the uniform system of accounts as outlined by the State Utilities Commission for private utility corporations.

The increase in operating expense in the water department over the previous year due to the war amounted to 21.5%. There was a decrease in revenue during the same period of 2.7%.

The increase in operating expenses in the light and power department amounted to 27.1%, but this was entirely offset by increased earnings. Rates have not been increased in either department.

Plant Extension

Because of lack of funds it is impossible to make electric extensions as fast as they are demanded. Pole and wire extensions to new consumers are made where persons interested in securing the service advance sufficient money to pay for the cost of material and apparatus required, such advances being returned in service. About 1,000 customers have been taken on in this way. Total cost of additions and extensions last year was $27,367.72. Money for building a utility plant in its infancy is usually provided by the sale of bonds but we are getting along as best we can without borrowing.

Growth of the commercial business in the light and power department is shown in the following table (street lighting is excluded):

Year ending	K. W. H. Supplied	Number Consumers	Gross Revenue
February 28, 1916	.....	286	$10,972.00
February 28, 1917	1,142,758	806	29,574.26
February 28, 1918	1,342,892	1308	40,072.17
February 28, 1919	1,796,966	1803	50,635.06

Power business has grown steadily. We now have over 700 horse power in motors connected. A number of electric stoves have been placed in service and have given complete satisfaction. A special rate of 2 cts. net per K. W. H. is made for cooking which makes the cost no more than for gas, while the electricity is safer and better.

Financial Benefits Derived

The financial benefits for the year accruing to the people of Springfield on account of combining the Municipal electric plant with the water works and entering the commercial field are summarized as follows:

Surplus earned	$22,779.16
Saving in street lighting	10,000.00
Saving by 1,803 consumers, account of the difference between the company and city rates	30,000.00
Reduction by private company from 13 to 11 cts. due to movement to establish combined city plant	25,000.00
Total annual saving	$82,779.16

Moreover the low rates offered by the city have induced many citizens to wire their homes and become electric users, thus bringing this great convenience more nearly within the reach of all. We have connected at least 150 of such customers the last year.

Design of New Filters Influenced by Experience Gained from the Operation of Original Filters at the Minneapolis Plant

By Lewis I. Birdsall, Superintendent of Purification Division, City Water Department, Minneapolis, Minn.

The demand for filtered water in Minneapolis has far exceeded the estimates of the engineers who designed the original water purification plant. The two coagulation basins and twelve filters put in service in January 1913 had a rated capacity of 39,000,000 gals. daily. Two coagulation basins and four additional filters were constructed during 1914 and 1915 which gave the plant a total rated capacity of 52,000,000 gals. per day. It was found necessary in 1917 again to increase the capacity of the plant. Eight new filters are at the present time nearing completion and will be ready for service during the hot weather of 1919. Two more coagulation basins are under construction and when these are completed the plant will have a total rated capacity of 78,000,000 gals. daily.

Experience gained from the operation of the twelve original filters pointed out necessary changes in the design of the four filters built in 1915 while more recent experience has led to further changes in the design and equipment of the eight new filters.

Filter Bottom Troubles

This subject was discussed in a paper presented by the writer at the Richmond meeting of the American Water Works Association.*

It was there pointed out that failure of the Tobin bronze strainer plates and bolts in the Minneapolis filters was due to lact of proper annealing of the metal after it had been cold worked. Proper annealing of the metal practically eliminated these troubles and very few failures have occurred since.

Strainer plates and bolts made of medium brass did not crack as did the Tobin bronze but the brass plates bent out of shape easily and so it was thought best not to use the medium brass in new installations. Monel metal plates and bolts in stalled as an experiment in one filter in 1914 have shown no failures whatever. It was therefore decided to use monel metal plates and bolts in the eight new filters. The cast monel metal eye bolts and nuts were made at the factory, while the strainer plates were cut, drilled and shaped on the job by an experienced sheet metal worker.

The strainer plates in the original filters rested on shoulders formed in the sides of the concrete ridge blocks, neat cement being used to seal the openings between the plates and the blocks. Experience demonstrated that the concrete shoulders broke down in time partly from action of the water but more especially due to the chisels of the workmen whenever it was necessary to remove a plate. Mr. W. N. Jones, engineer in charge of filter design and construction, has therefore installed in the new filters cast iron plates, having machined shoulders to receive the edges of the strainer plates. These cast iron plates serve as lateral forms for the base of the ridge blocks which are poured in place. Red lead is used to seal the joint between the strainer plates and the cast iron shoulder. Whenever necessary the strainer plates may be easily removed without damage to the ridge blocks. The strainer plates are held in place by monel metal eye bolts through the eye of each bolt there being a monel metal rod supported in notches cast in the iron plates.

The underdrains of the original filters consisted of 20-in. cast iron pipe from which there were four 14-in. risers on the center line of each half of the filters. A central passageway

*Some Practical Problems in Filtration Plant Operation, by Lewis I. Birdsell. Journal of the American Water Works Association, Vol. 4, No. 4, December, 1917.

underneath the strainer plates extended longitudinally of the filters and from this the lateral passages extended between the ridge blocks. It was found that most of the breaks in the strainer system of the old filters occurred over or near the 14-in. riser pipes. In all of the later filters this arrangement of the collecting system was eliminated. The 20-in. pipes are now cast in manifold form with a 3-in. riser between each pair of ridge blocks which are now made continuous across each half of the filter, there being no connection longitudinally of the channels formed between the blocks. This arrangement has worked very satisfactorily and has given an excellent wash in the four filters put in service in 1915.

It has been found by experience that notwithstanding the greatest care on the part of those in charge of the filter construction work much debris accumulates in the underdrains during the construction of the filters. When the original filters were put in service an ordinary blow torch which had washed from the underdrains into the filtered waste valve could be removed only by taking the valve apart. Chunks of concrete and other debris lodged in other valves and caused trouble. In order to eliminate these troubles in the new filters the 20-in. collector pipes are now extended through the wall into the pipe gallery where the ends of the pipes are closed with blind flanges. It is now a simple matter to inspect and clean these pipes at any time.

Auxiliary clear water basins were not built under the twelve filters last constructed because of the ample storage capacity (45,000,000 gals.) for filtered water already existing. It was considered of more importance to have dry wells under these filters so that the collecting pipes might be accessible for frequent inspection and for painting.

Filter Valve Troubles

Much trouble has been experienced by leakage through the wash water valves of filtered water from the wash water tank. This water is not wasted unless the filters are out of service but with considerable leakage the wash water pumps are kept busy keeping the tank full. The wash water valves on the original filters and also on the four filters built in 1915 are 24-in. hydraulically operated double disc gate valves placed with the stem horizontal and the discs vertical. The discs are faced with bronze rings which seat against bronze rings in the body of the valve. Investigation has shown that the frequent opening and closing of these valves under a pressure greater on the wash water tank side has caused the discs to bind on the bronze seat rings on the filter side of the valves, thus scoring the seat rings at the top and bottom. It was impossible to remove the rings without injury to them as the lugs had all been removed before the valves were received from the manufacturer. Otherwise the rings might have been refaced and returned to place.

Similar trouble was experienced with several of the 30-in. hydraulically operated sewer valves but on investigation it was found that the discs had either opened too far and in closing had caught and torn loose the seat ring or else some hard foreign body had lodged between the discs and the rings and caused the damage. The latter explanation did not seem logical in view of the way in which the valves were set and the large opening of the valve.

New seat rings were ordered from the manufacturers but when these were received it was found that the rings were not of standard size, in fact no two valves of the same size appeared to have the same size of seat rings. It was necessary to caliper each ring seat carefully and have the rings machined to fit. The engineer in charge of filter construction has stated that these valves were ordered under specifications which required that all valves of the same size should have their parts interchangeable. It would appear that the valve manufacturers do not deem it important to use a standard size of seat rings in their valves even though it means much to those who use them.

Specially designed and constructed hydraulic valves for the wash water and sewer lines of the eight new filters were ordered at an additional cost, which, however, appeared to be justified in view of previous experience. These new valves have lugs attached to the discs in such a manner that the discs travel on tracks and rollers so arranged that the discs cannot bear against the seat rings until the moment that the gate seats. It it hoped that these new valves will be free from the difficulties previously encountered.

Trouble with Hydraulic Control of Valves

All of the valves connected with the Minneapolis filters are hydraulically operated from operating tables. The necessary water pressure is obtained from an elevated tank, and amounts to a 50-ft. head at the manifold of the operating tables. The piping from the manifold of the operating tables to the hydraulic cylinders on the valves is ¾-in. in the case of the twelve original filters. It was found that the wash water and sewer valves required approximately six minutes for opening or closing. When the four additional filters were built larger four-way cocks were specified for connecting with 1-in. pipes leading to the hydraulic cylinders of the wash water and sewer valves. This change resulted in the valves opening and closing in about one-half the time, but still too slowly to be satisfactory.

The installation of a pressure pump would have given sufficient pressure to operate the valves rapidly at all times and in fact such a pump was installed for opening valves which stuck. It was desirable, however, to be able to operate all of the filter valves with the elevated tank pressure as the electric power supplied to the plant often kicks out during heavy thunder storms. Therefore, 1½-in. pipe connected to special four-way cocks of the same size were installed on the operating tables of the eight new filters. The result has been highly satisfactory, the wash water and sewer valves opening and closing in less than one minute. The amount of wash water saved through a quick opening of the valve has not been calculated, but it undoubtedly amounts to a large quantity in a year.

Electric Versus Hydraulic Effluent Control

Electrically operated automatic effluent controllers were installed on the first 16 filters, but experience has shown that electric control is unsatisfactory at certain times, especially when the power kicks off during electric storms. Also the habit acquired by some of the motors to run wild and open wide the butterfly valve on the controller unless observed in time, causes constant worry to the operators. The electrical apparatus exposed as it is in the pipe gallery to constantly moist air requires considerable supervision and maintenance.

The eight new filters have been equipped with hydraulically operated effluent controllers to obviate the above mentioned difficulties. All of the controllers are connected with a master controller operating in such a manner that the rate of filtration of each filter can be automatically controlled between maximum and minimum rates as predetermined and the rate varied automatically according to the level of the water in the clear water reservoir.

The chlorine machines now being installed in duplicate for the new filters are designed to operate automatically in proportion to the rate of filtration. The chlorine machines may, however, be manually controlled if so desired.

Other changes in the plans of the new filters have been the installation of an extra wash water gutter in each half of the filters so as to decrease the lateral travel of the dirty wash water and the filling up with cinder concrete of a portion of the rear end of the central gutter of each filter so as to save the wedge of water that is otherwise wasted each time that the gutter is emptied for washing of the filter.

Chlorination of Swimming Pool Water

"Chlorination of swimming pools is apparently highly efficacious," says C. G. Gillespie, director of the Bureau of

Sanitary Engineering, California State Board of Health. "Where it is employed in connection with a circulating system it appears to impart a prolonged disinfecting property to the pool water which is able to cope with the pollution subsequently added as a result of bathing. The explanation of the longer duration of the action in swimming pools than in drinking water supplies may be that the organic matter in the swimming pool forms, with chlorine, the 'chloramie compounds' which have been shown to give slower but far more lasting results than the free chlorine itself. Ordinarily, 0.5 lbs. of chlorine per 100,000 gals. of water added is sufficient for swimming pool disinfection. The chemical may be added in the form of chlorine gas, in which case a chlorinator apparatus is used, or it may be used in the form of bleaching powder mixed into a solution and fed into the supply at a rate proportionate to the flow. Bleaching powder is weaker than the chlorine gas by about 70 per cent, therefore about three times as much, or 1.5 lbs. per 100,000 gals. must be used. Works for the handling of bleaching powder consist of a concrete tank holding about 300 gals. and a small concrete orifice tank for regulating the feed of the solution, besides appurtenant piping. In either case the chemicals may be applied at any point in the circulating system.

"Existing pools not equipped with a circulating system may easily provide for disinfection of incoming water by either of these means and largely fortify the pool water against contamination. In pools where the supply of water is particularly low, considerable benefit may also be obtained by splashing the bleaching powder solution evenly over the entire pool just as the bathing stops, so that the wave disturbance may tend to diffuse the chemical throughout the depth of the pool and to disinfect it."

How Vinton, Iowa, Obtained a Dual System of Water Supply

By J. H. Dunlap, Associate Professor of Hydraulics and Sanitary Engineering, College of Applied Science, State University of Iowa, Iowa City, Iowa.

The Domestic Water Supply

By drawing its domestic water supply from wells reaching to the Jordan sandstone, 1,400 ft. below the ground level, and by utilizing the water of the Cedar river flowing just at the rear of the water works pumping plant, the city of Vinton, Iowa, has been able to provide pure water for domestic consumption and also a much softer water for manufacturing purposes. To accomplish this, two separate distribution systems and two separate pumping systems were necessary. While neither the well water nor the river water is as soft as is desirable, yet it is a great advantage to the industrial prospects of Vinton to have the 561 parts per million total solids in the deep well water reduced to less than 228 parts, which is the mineral content of the Cedar river at Cedar Rapids, some distance below Vinton.

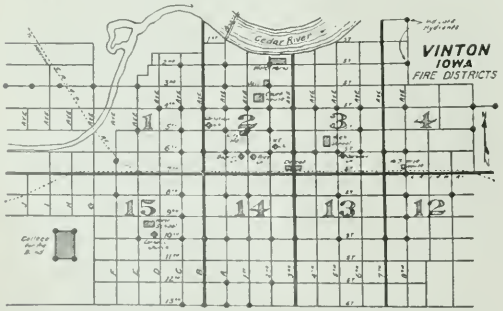


FIG. 1—VINTON, IOWA, SHOWING THE LOCATION OF THE WATER WORKS AND FIRE HYDRANTS.

Deep Wells and Air-Lift Pumps

With a population in 1915 of 3,996, Vinton lies at the extreme western limit of the area in which the quality of the water obtained from the Jordan sandstone is suited to domestic use. Nevertheless, the well water is so hard that it would be very costly for manufacturing use, and would greatly handicap the city in its future industrial development. It was in 1890 that Vinton turned to deep wells for its source of supply after having some experience with shallow wells. There are now two wells, one 1,297 ft. deep, one 1,410 ft. deep. The first well is 5 ins. in diameter at the top and 4 ins. in diameter at the bottom, while the second is 5 ins. in diameter throughout. Each well has 610 ft. of casing and cost complete with the casing $5,300. Originally the wells were flowing wells, but now

FIG. 2—LEFT TO RIGHT: THE WATER WORKS PUMPING PLANT, THE INTAKE WELL, THE INTAKE AND THE CEDAR RIVER.

the water will rise only to within about 8 ft. of the ground surface. By using air-lift pumps each well is made to yield 250 gals. per minute.

In July, 1917, while on an inspection trip for the Iowa State Board of Health, the following facts were noted.

About 80 per cent of the population were reached by the water mains. The number of service accounts was 750 with 735 of them metered. It was estimated that the domestic consumption of well water was 100,000 gals. per day. It is interesting to add that in addition to this the industrial and manufacturing use was 120,000 gals. per day of river water.

Air Lift Equipment

The deep wells are pumped by two air-lift pumps each connected to the same air receiver. A new Ingersoll-Rand single stage 10x10 in. air compressor is belted to an overhead Westinghouse motor of 35 h. p. at 220 volts and 1,150 r. p. m. The air receiver is 6 ft. high by 2½ ft. in diameter. In addition to the new compressor an older one is kept in reserve. The pressure to start the air-lift pumps is 120 lbs. per sq. in., which drops to 90 lbs. when pumping begins. From the air receiver a 2-in. pipe runs to the farther well, and a 1½-in. pipe to the nearer well. These air pipes extend down 250 ft. into the wells, ending in Harris air-lift foot-pieces. The air-lifts pump the water into a surface reservoir of 40,000 gals. capacity.

From this surface reservoir a motor-driven Union 3-In. centrifugal pump throws 300 gals. per minute at a head of 176 ft. into an elevated steel tank on a steel tower 160 ft. high. The motor is an induction motor of Westinghouse manufacture, 25 h. p. running at 220 volts and 1755 r. p. m. The air compressor and motor cost $1,222 in 1917 f. o. b. Vinton, the centrifugal pump $108 and its driving motor $462.

Distribution System.

The distribution system for the domestic water supply consists of nine miles of 10-in. to 4-in. cast iron pipe. There are 71 fire hydrants with 51 gate valves on this system. The

elevated tank has a capacity of 70,000 gals. For fire protection a Gardner fire pump is used. This is a simple, duplex pump 18 x 10 x 12 ins., rated at 1,200 gals. per minute at a piston speed of 141 ft.

Pressure

The domestic pressure maintained at the pumping plant is 68 lbs. per sq. in., which is increased in time of fire to 110 lbs. per sq. in. There is very little loss of head in the distribution system under ordinary conditions, since the town lies so close to the pumping plant. The maximum difference in elevation between the pumping station and the highest part of the town is about 25 ft.

Water Rates

The following rates are charged for this deep well water:

40 cts. per 1,000 gals. for the first 5,000 gals.
35 cts. per 1,000 gals. for the next 5,000 gals.
30 cts. per 1,000 gals. for the next 10,000 gals.
20 cts. per 1,000 gals. for all over 20,000 gals.

Meters are read in April, August and November with a minimum of 50 cts. per month.

The Industrial Water Supply System

In contrast with this domestic water supply it is interesting to compare the separate distribution system used to carry the water directly from the Cedar river to the railroads and factories. This river distribution system consists of about 1⅛

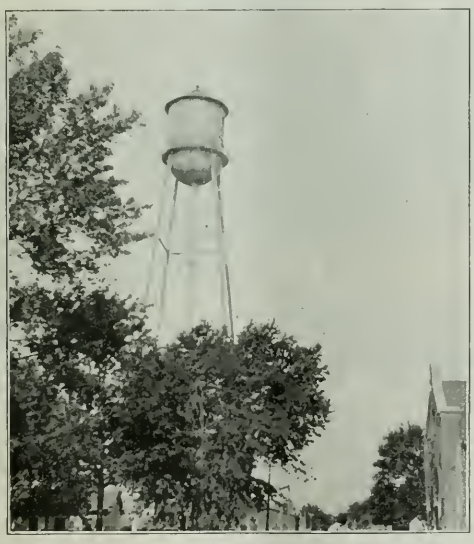


FIG. 3—THE ELEVATED STEEL TANK OF THE VINTON, IOWA, WATER WORKS. HEIGHT, 160 FEET; CAPACITY, 70,000 GALLONS.

miles of 4-in. cast iron pipe. The intake is in the Cedar river immediately at the rear of the pumping station. The water receives no treatment, but its mud content settles out to a considerable extent in a large intake well. From the intake well a simplex Union tandem-compound steam pump, 12 x 18 x 12 x 16 ins. pumps directly into the river distribution system.

The river water is sold at a uniform rate of 8 cts. per 1,000 gals.

While not many cities are so situated that a dual system of water supply is possible, it has proved in the case of Vinton to be well worth while to take advantage of local opportunities in this respect.

Features of the Well System of the Dayton, Ohio, Water Works

By H. C. Wight, Superintendent Division of Water, Department of Public Service, Dayton, Ohio

Dayton is fortunate in having a water supply from wells which have not only proven sufficient in the past, but seem adequate for future development. The water is close enough to the surface to be pumped by direct suction, thus eliminating deep well troubles or air-lift expense. A supply of this type is worth much to a city. The water leaves the pumps at 61 degrees in the summer time and at 58 degrees on the coldest winter days. Its quality is excellent, samples for the last month averaging 9.4 bacteria per cubic centimeter without treatment or artificial filtration. It costs little more to secure than unfiltered lake water, which, of course, is not as desirable in these days of sewage problems.

A number of years ago the adequacy of the local well system was questioned. Today we are pumping more water with less trouble, principally due to minor changes and necessary repairs. The average consumption per day is 15,000 000 gals., and more than 20,000,000 gals. have been delivered on a number of days, at rates of pumpage varying from ten to forty million gallons. A large equalizing reservoir was completed in 1918, and serves to remove the peak loads which came on summer afternoons when the people sprinkled their lawns. Instead of opposing the use of water for sprinkling, as many cities have done, Dayton has gone on record as favoring it, as we have the water and make a profit on each gallon sold.

Four Groups of Wells

The water is secured from four groups of wells. The first, or old group, is located in Mad River, near the pumping station. and contains 96 wells, though many of these are poorly spaced and of little value. The second, or Aqueduct group, is located just east of the main group and contains 6 wells. It is pumped by a low- lift centrifugal pump and yields 3,000,000 gals. per day. This group was developed in 1910. The third group is located 13,000 ft. east of the main group and connected thereto by a 36-in. iron conduit. It contains 27 wells and is pumped by two 5,000,000 gal. electric units, which when operated singly have a capacity of 6,000,000 gals. each. This group was completed in 1915 and is called the Tate's Hill group. We are just now completing a fourth set of ten wells, 1 500 ft east of the third group. These wells have been the most remarkable of any on record.

Just south of Mad River and between the first and second sets of wells, an artificial basin existed built originally for making ice. This pond has been divided into three acre groups and can absorb more than 10,000,000 gals. a day. The amount of the water which filters through and reaches the city supply is probably small as the normal flow of the ground water is to the southwest. It is very possible that the down filtration takes the place of the normal flow which has been stopped more or less by the draught of the wells. This pond is flooded by gravity from the Miami and Erie Canal Feeder or by a 10,000,000 gal. unit which takes its suction from the Mad River.

All of the water from the electric stations goes to the main plant where the pressure is raised to the desired amount. We have two services one of 75 to 80 lbs. and the other of 130 lbs. The high service load is equalized by means of a 900,000 gal. stand pipe.

Overcoming Air Trouble

Well water contains a certain amount of air. Unless this water flows to a reservoir by gravity, this air will cause trouble when pumped. All water works men are familiar with occasional leaks in the pressure mains. They are not always as familiar with suction leaks which cause more trouble and are harder to locate and repair especially if the leak is in the well pipe or in covered mains. A lot of our air trouble has

SERVICE
CAST IRON PIPE
MEASURED BY
CAST IRON PIPE
CENTURIES
THE FIRST CAST IRON PIPE EVER MADE IN THE WORLD'S HISTORY IS STILL IN SERVICE
MORE THAN 250 YEARS OLD

CONTINUOUS

A story of long

The Cast Iron

1 Broadway

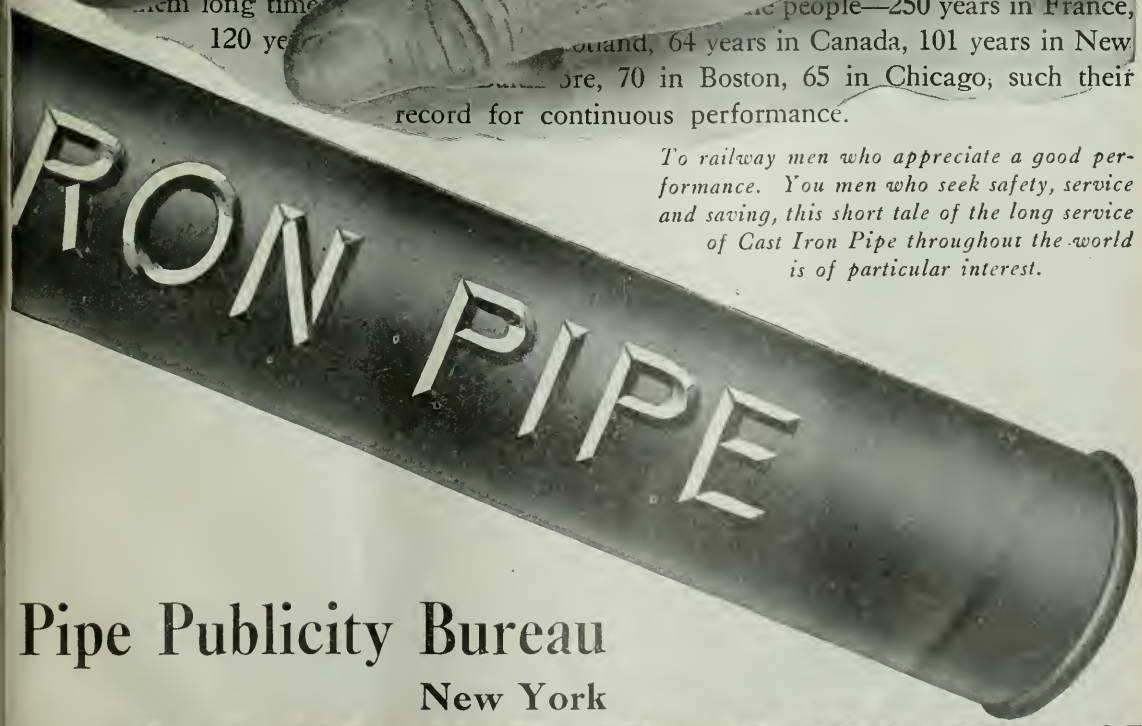
PERFORMANCE

time on the big circu

THIS is no tale of t
in the life of pi
short engage
The fact is t
—thro

rmance has
em long time
people—250 years in France,
120 ye
land, 64 years in Canada, 101 years in New
re, 70 in Boston, 65 in Chicago, such their
record for continuous performance.

To railway men who appreciate a good performance. You men who seek safety, service and saving, this short tale of the long service of Cast Iron Pipe throughout the world is of particular interest.



Pipe Publicity Bureau

New York

been overcome by removing the air by means of air chambers and vacuum systems. These remove air from all of the high points on the system and keep the air from the pump chambers.

The future development of the Dayton water system will probably be around wells. The individual groups may possibly be kept below 10,000,000 gals. daily capacity. The underground vein of water which is tapped passes under about half of the city. Well systems are often scrapped on account of difficulties which might easily be overcome. If well water is obtainable, it is worth much both to the people supplied and the producing water company.

Reduction of Water Consumption by Means of Pitometer Survey and Constant Inspection at Buffalo, N. Y.

By George C. Andrews, Water Commissioner, Buffalo, New York.

In 1897 the Buffalo Common Council decided it more advantageous to its citizens to install more pumps and give practically an unlimited supply of water than to control consumption by means of meters. It is hardly necessary to add that this decision was made contrary to sound engineering advice. Free water is a slogan that often appeals to the unthinking. It would be interesting to speculate on what that decision has cost the citizens of Buffalo in the past 22 years. Suffice it to say that in 1903 the Bureau of Water had a bonded debt of $3,699,382, while it was $12,141,524 in 1917. From that date until 1917 it was a race between the unchecked waste both in mains and in houses and the pumps.

In 1903 there was one pumping station with a daily capacity of 183,000,000 gals. In 1917 there were two pumping stations with a combined daily capacity of 330,000,000 gals. Coincident with the increased pumping capacity large distributing mains were laid. During this period the per capita consumption had ranged between 302 and 339 gals. per day. Of this practically 100 gallons was for industrial use.

Pitometer Survey of Small Section Made to Test Value of Method

In 1916 the city government was altered and a commission of five men elected to govern the city. Their platform was an economical and efficient city government and one of the early efforts was an investigation as to means to reduce the city water consumption. As all water used must be pumped from Lake Erie against a head of 140 to 204 feet, a reduction in pumpage would make an immense saving in coal used for fuel. Various methods were considered and in the Spring of 1917 it was decided to have a pitometer survey made of a small section of the city with the idea of covering the whole city later should this section show satisfactory results. The question of metering was considered but rejected on various grounds, some of which were: popular local prejudice against metering, length of time to completely meter city, there being over 76,000 unmetered and active services, while the pitometer method promised early results; extensive changes in plumbing required should meters be installed in many of the poorer types of dwellings, heavy initial investment required for meters.

City Divided Into Ten Sections

To facilitate the work and also that definite records could be obtained of water consumption in different points, the city was divided into ten sections none of which were similar in character and work completed by sections.

Section 1 included manufacturing use, poor, good, and high grade residential districts.

Section 2 is an old residential section with most of the buildings antedating the modern sewer and water service. In this section the toilets are usually of the so-called anti-freezing type installed in a shed in the rear of the house. The waste in this section was tremendous.

Section 3 is a section of the city sub-divided in the 90's, when water mains, sewers and services were laid. This section is only now being developed. The residences built are of fair construction. In this section the rock lies close to the surface and in many streets water mains and house services are laid in the sewer trench. The value of the pitometer was proven in this section as ever-leaking unfinished supplies which were discharging into the sewers were discovered and stopped. Along Fillmore Ave., quarries had been opened years ago and water from a broken 16-in. main discharging into the face of the pit had for years furnished excellent water for men and teams working in the quarry.

Section 4 is principally high class residential, such as the Delaware Park section. Western portion, however, heavy manufacturing use of water and poor class dwellings, 75% of this section is built on rock strata close to the surface.

Section 5 is high class residential, principally, with eastern portion of middle class dwellings. No manufacturing use of water.

Section 6 takes in the heart of the business section of the city. Northern portion is composed of middle class dwellings but 80% of water is used commercially.

Section 7 includes poorer class dwellings and large manufacturing use of water. All the big packing houses and stockyards are included in this section.

Section 8 includes most of the water front of the city with large manufacturing plants and commercial use of water. Poor class of dwellings and the oldest section of the city.

Sections 9 and 10 include middle class dwelling with some large steel mills on the outskirts. Also railroad yards are large consumers in these sections.

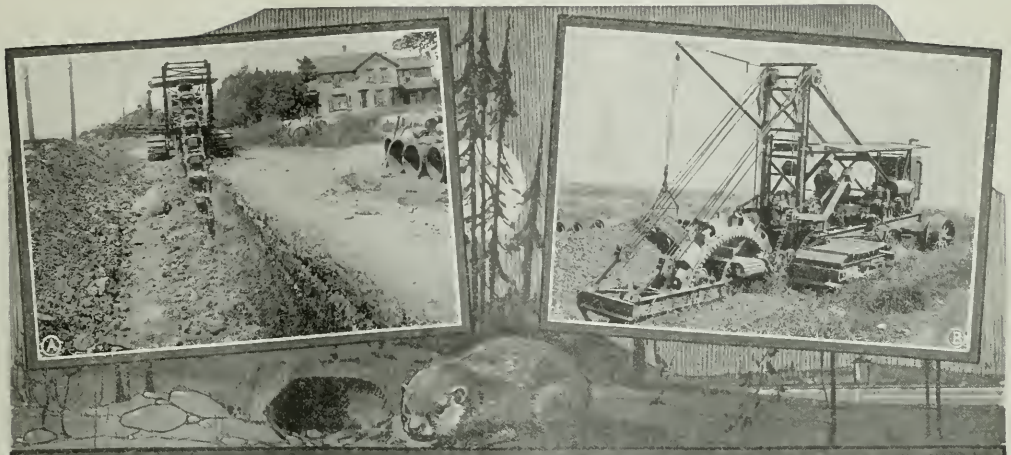
Theory of a Pitometer Survey

The theory of a pitometer survey is briefly described as follows: A certain section of the mains is isolated by closing all but one of the boundary valves. A special corporation cock is inserted on the main feeding this district through the open valve. The main is traversed and the velocity of the water determined by the instrument inserted in the main through the corporation cock. Gaugings are recorded on sensitive paper for 48 hours and from the velocities shown the flow computed. As all the water entering this section passes the instrument the amount measured must be the consumption of the district. The interesting or indicating feature of these records is the relation between the minimum night rate, which is usually found between 12:00 P. M. and 3 A. M., and the total 24-hour consumption. A high night rate, unless accounted for industrially, means leaky fixtures or breaks in mains.

As the isolation of a section is apt to leave some industries just within and without the district short on water pressure causing complaints of low pressure a map is kept in the office of the Superintendent of Maintenance on which all valves closed are indicated by a red headed pin. By this means one can at a glance determine if a complaint of lack of pressure is due to the pitometer work or to some other cause. These pins for closed valves are corrected each morning.

Sub-Division Work

After the total measure of a district is made, sub-division work is started. Sub-division is the determination of the consumption block by block and is always done at night. The pitometer is set at the gauging point and the district shut off block by block, the time of each shut off being noted. By comparing the time with the consumption shown on the photo chart at the corresponding time the rate for each block can be determined. This is a very important feature of the pitometer work as by comparing the consumption for the different blocks one knows immediately where the inspection of fixtures will give the greatest result. It is an especially valuable feature for the control of the house waste after a survey has once been



GROUND HOGS

—because they open up trenches quickly and neatly! Look them over.

A—This is the Ladder Type P & H Excavator making a ditch thru hardpan and boulders for a contractor down in Illinois. It's a powerful machine, fabricated of steel thruout, designed for sewer digging and general heavy trenching to 20 feet in depth.

B—Is a Wheel Type P & H Excavator opening the ground for a drain pipe-line. This is the outfit for pipe-line, conduit, and farm drainage excavation. Built of steel for light weight and flexibility; digs trenches 7½ feet deep to 28 inches wide.

C—A machine with a multitude of uses—the 205 Dragline P & H Excavator. What it will do: Excavate open or sloping bank ditches, clean out old ditches, dig cellars and holes, strip coal, grade streets, backfill trenches, load or unload coal, crushed rock, screenings, sand or gravel, and last, but not least, it is a complete, portable locomotive crane with a lifting capacity of 3500 pounds.

D—Getting the dirt back is sometimes as troublesome and costly as getting it out. This machine makes it easy and does it in a hurry on one man's time. Just the outfit for city streets where work must be done with uniformity and dispatch. The P & H Backfiller has capacity to take care of the largest sizes of trench excavators.

You may not need P & H Excavating Equipment right now, but write for Bulletin X and keep it handy.

PAWLING & HARNISCHFEGER CO., Milwaukee, Wis.

P&H — excavators, backfillers, tampers.

made. By means of the pitometer and proper sub-division, house to house inspections can give results twice as quickly as though no pitometer were used, as efforts will be confined to blocks where the sub-division indicates the greatest results are to be obtained.

Immediately after the sub-division work was completed, inspectors were placed in the district and house to house inspection made.

Organization for Survey

To make the survey, an engineer in charge and four assistants were employed. Three trucks with gangs of four were constantly engaged and one clerk assigned to this work to keep the records. Twelve of the regular city inspectors made the house to house inspections. Later, as more of the city was covered, 20 temporary inspectors were engaged.

One of the assistant engineers made the district measurements and two were constantly engaged on sub-division. One assistant engineer tested the meters and fire lines. During the winter months two men worked in the office.

The inspection for house waste is of great value, and a large percentage of the total waste eliminated is directly due to inspection. However, proper control must be exercised or the results will be indifferent. From 1906 until 1915, the department employed men to stop house waste, but had no control over it by means of district measurements. During this period the per capita consumption was practically stationary, although the annual consumption increased.

Inspection Records

As the sub-divisions showed waste in practically every block, a system of inspection records was developed. Inspectors worked in pairs and a report on every house and service made. Where leaks were discovered, a repair notice was left. Two weeks later a second inspection was made of all places where notice to repair was served. If repairs had not been made at that time a second repair notice was left and a re-inspection made three days later, at which time water was turned off, unless all plumbing was in good shape. The years of unlimited use and waste of water had rendered most people indifferent to the condition of the plumbing in their houses and at first considerable complaints were made at the so-called arbitrary ruling of the bureau. However, these soon ceased as the results of the survey became apparent and in the majority of cases splendid co-operation was secured.

The inspectors tested, first the house fixtures and then if these were O. K., tested with the aquaphone at the curb box for service leaks. If house waste was found, stop cock at the house was closed before testing for service leaks. On their inspection report blanks leaks were listed as service, faucet, toilet, etc., and a notice showing the nature of the leak served. A record of the number of people on each service was als reported. After the house inspection in a district was completed, the pitometer was again used to record the flow in different blocks in the sub-division. Where the night rate was still excessive, investigation for underground leaks was started. The determination of underground leaks is largely a matter of skill, judgment and experience. By sub-dividing by blocks the leak can be located as to block, but then the operator must find it by skill and judgment. If service pipes and boxes have been installed the aquaphone can give one the approximate location, and by driving a steel rod to the main the leak can be closely located. In only a few cases was it necessary to excavate more than one hole to find the leak.

Seven Service Leaks at One Place.

Probably the most difficult work in this line was on Northland Ave., in Section 3, where a night rate of 755,000 gals. was shown on one block. As there were practically no houses, and only one factory which was metered and did not account for but a fraction of the flow, all indications pointed to a large joint leak, or cracked pipe. In this street the pipe is laid in the sewer trench, which was excavated through rock. When the street was paved in 1893 house services had been placed every 60 ft. No large main leak was encountered, but seven service leaks were discovered and shut off at the main, which accounted for 700,000 gals. or practically the entire waste. The corporation cocks had in nearly every instance been destroyed and water was discharging directly into the sewer. No indications of these leaks appeared on the street surface.

Permanent Map of Gauging Points and Valves

As work was completed in each division a permanent map was filed in the office, showing gauging points for instrument and valves on boundary points. On this map is recorded date of first measurement, 24 hours consumption and minimum night rate, and same record of second measurement. It is the intent of the Bureau of Water to continue the pitometer work as a special department and regular measurements will be taken at varied intervals, and these maps will facilitate the work greatly. All inspectors' reports are filed by streets and can be instantly referred to. As soon as a section was completed a full report on it was submitted by the engineer-in-charge. This report gave a general summary of the work with certain specific recommendations to meet the conditions for the sections. These reports are filed so as to be available for future reference.

Results in One Section

The report for Section 4 showed as follows:

Total flow before inspection per 24 hours ....17,936,000 Gals.
Minimum night rate .....14,912,000 Gals.
Per cent. of night rate to total flow..... 86.2%

Inspection of all buildings on this section showed: 3,444 leaky fixtures, divided as follows: faucets 1,064; toilets 2,380.

It also disclosed 280 leaky services, which were repaired by the owners; 8 unfinished supplies which were discharging into the sewer were dug up and plugged. Also, one broken 6-in. main was uncovered and repaired.

After the house inspection and underground work was completed a re-measurement was taken with the following results: Reduction in daily consumption 3,780,000 gals.; reduction in night rate 3,910,000 gals.

On acount of the desire to reduce the pumpage as quickly as possible, so as to conserve coal as a war measure, no intensive work was attempted and the city surveyed as rapidly as consistent with good work. It is highly probable that the results in this section could have been bettered had more time been devoted to it. However, by extending the work rapidly large leaks in other districts were detected and stopped in the time which might have been devoted to more intensive work in this section. It is expected that the work to be done in this section this summer will materially better the above result.

The efficiency of the survey as a means of reducing water consumption is shown by the records kept.

Before the survey there had been a gradually increasing yearly consumption, which in 1916-1917 showed a daily consumption of 168,000,000 gals. Had no effort been made to check this waste of water the present years would have called for a daily pumpage of 186,000,000 gals.

However, starting in July 1917, which was coincident with the start of the survey, each month showed a decrease in pumpage when compared with the same month in the preceding year except for the extremely cold months of December, 1917, and January and February 1918.

Peculiar Local Conditions

The records bring out very clearly two conditions more or less peculiar to Buffalo. Water consumption in the summer months is usually higher than the monthly mean, while the months of December, January and February are excessively greater. Buffalo's homes are usually set well back from the street and surrounded by a grass plot. This not only applies to the homes of the rich and well-to-do, but to the poorer classes as well. Practially 50% of our bills have a sprinkling

charge indicating that occupant uses a hose for sprinkling lawn or street. From 5:00 to 9:00 o'clock on summer nights we are likely to have close to our peak loads of the day at the stations and the water used for sprinkling is enormous in the aggregate.

Besides this use in the summer time we have an excessive waste in the winter from the anti-freezing closet. Most of these have been installed in the older sections of the city and the majority are in bad repair. Our records show close to ten thousand of them still in use. Besides these the plumbing installation in many of the cheap houses has been such that to keep pipes from freezing it is necessary to allow water to run. The effect of this is shown by consumption in winter months.

More careful inspection of new plumbing is now being made and the anti-freezing closet is being gradually eliminated. When these are all done away with a great source of waste is gone.

Amount of Waste Curtailment

Our first section was surveyed in 1917 and this year re-measurements have been taken. These show that there is a more or less gradual return of the waste first eliminated, depending wholly on the character of dwellings. In all sections the consumption was less than it was two years ago at the time of the first measurement. In one case the result showed only 20% increase over the first re-measurement. I estimate that effects of the result of the survey will be from one to three years as far as house waste is concerned. All underground leaks stopped are a permanent saving.

In the sections completed the house waste stopped is estimated at 18,000,000 gals., while the underground waste stopped was 12,000,000 gals. by actual measurements.

City to be Surveyed Once in Two Years

It is our intention to measure and sub-divide the entire city once in two years and completely to inspect as often. Of course measurements and inspections will be made oftener in the sections where waste is greatest. To control waste more fully in these sections meters will be placed gradually.

Quick Results Obtained

However, to reduce our pumpage quickly was imperative. I know of no other way which would have given results so quickly. To install meters would have taken from three to five years and the reduction would not have been felt for some time —at least not for the first six months when the size of the bill would have brought the waste of water home very forcefully to the householder.

In dividing the daily consumption the legitimate household use was assumed at 50 gals. per capita per day. The industrial use was assumed to be our total metered use, as practically all industries are metered. This use is practically 100 gals. per capita per day. It is hard to account for such a large industrial use of water per capita in a city the size of Buffalo. In my opinion it is directly due to the low meter rate of 2c per 1,000 gals. which for a long time was the charge here. This, in conjunction with a fairly high minimum charge for a meter, made the average metered service user indifferent to the amount of water used. The larger consumer, as a rule, found it cheaper to waste water than to investigate for leaks. Buffalo is also a large railroad center and the city supplies the railroads with water. In 1917 the meter rate was raised to 4c per 1,000 gals.

Summary of Results Secured

Nine tenths of the city has now been covered by the survey with the following results:

33,278 Leaky fixtures reported and repaired.
1,860 Leaky services reported and repaired.
52 Unfinished supplies found wasting 3,587,000 gals. per day. Broken mains and leaky joints wasting 4,376,000 gals. per day found and repaired.

The services, broken mains, unfinished supplies and leaky joints repaired account for 12,000,000 gals. waste per day permanently stopped.

The pumpage has been reduced except in times of extremely hot or cold weather to less than 125,000,000 gals. per day, as compared to over 160,000,000 gals. per day in 1917.

Cost Data

Figuring the cost of pumping at $6.24 per 1,000,000 gals., the average cost for the last three years, the annual saving is $68,328. Against this is the estimated charge of $25,000 per year to maintain the Pitometer Division of the Bureau.

To date the survey has cost $96,931, much of which represents permanent investment in equipment and records, or for professional services.

Absolute Written Guarantee Against Freezing

McNUTT *GUARANTEED* METER SETTINGS

SAVE TIME, TROUBLE AND EXPENSE

There is no guesswork or verbal promise about the freeze-proof features of **McNutt Meter Settings.** Thorough testing in actual service enables us to give an absolute *written* guarantee with every setting.

McNutt Meter Equipment prevents freezing, saves time and trouble in reading and setting, and eliminates 75 per cent of time in taking out and replacing meters. The McNutt Easy-to-Read 15-inch box, with hinged lid, guarantees protection and eliminates the old-style 18- and 20-inch boxes. The Easy-to-Install Yoke places risers 9-inch centers, pipes closest possible and farthest from frost line.

Write for complete information.
Read our Absolute Guarantee.

McNutt Meter Box Co.

Box M 1. BRAZIL, IND.

Including the pay of temporary inspectors, who will be employed each spring, it is estimated that the annual cost of continuing the work will be $25,000 per year.

From the survey made and results obtained it is evident that to a certain extent the house waste can be greatly reduced by house inspection controlled by pitometer measurements. When used in conjunction with selective metering the most flagrant house waste can be eliminated and the consumption reduced nearly to that obtained by universal metering and done at less expense. The pumpage can be reduced at least 20,000,000 gals. by the installation of 10,000 meters on house services where tremendous waste has been found by the survey. The installation of these meters is now proposed. A further reduction is not deemed advisable until a filtration plant is built.

Cost Comparison of Universal Metering with Pitometer Control and Selective Metering

A comparison between the cost of universal metering and the elimination and control of waste by the pitometer and selective metering is briefly as follows:

Control by pitometer and selective metering:

Annual cost of inspection	$ 25,000
Installation of 75,000 meters Investment in meters $100,000	
Annual charge on meters, interest @ 4½%	4,500
Depreciation	4,000
Cost of reading and maintenance	6,000
Total annual cost	$ 39,500

Universal metering:

Installation of 75,000 meters Investment in meters $750,000	
Annual charges on meters, Int. @ 4½%	$ 33,750
Depreciation 4%	30,000
Cost of reading and maintenance	45,000
Total cost	$108,750
Annual saving in favor Pitometer control	69,250

It is true that universal metering would reduce the consumption considerably more than the other method, but even if the reduction amounted to 20,000,000 gals. per day the saving in operation costs would not equal $69,250 per year.

The efficiency of any instrument is determined by how well it does what it is intended to do. If the object had been to reduce the consumption to a minimum the proper thing would have been to install meters and then eliminate underground waste by pitometer investigation. However, in any large water works there are certain features peculiar to it. For instance, the Buffalo Water Works had, at the time a reduction in pumpage was decided upon, two pumping stations, each capable of supplying 150,000,000 gals. of water a day with mains properly built for distributing this quantity. If the pumpage is reduced to 110,000,000 gals. of water a day for nine months of the year, one plant can be shut down for that period. After that saving is affected a further reduction in pumpage saves very little per 1,000,000 gals. pumped, as practically the same force is required to operate the plant whether 75,000,000 or 120,000,000 gals. are pumped, and irrespective of the pumpage, interest on the bonds accrues.

Results Meet Expectations

Our intention was to reduce by this survey our pumpage from 159,000,000 gals. to less than 115,000,000 gals. and before the work is completed this result will have been attained. Moreover, the data has been furnished so we know how to reduce the consumption further by intensive inspection and the installation of meters in certain districts.

Acknowledgment

The foregoing matter is a paper, slightly condensed, presented by Mr. Andrews at the recent annual convention of the American Water Works Association held in Buffalo, N. Y.

Wm. Artingstall
Civil Engineer
Old Colony Building Chicago

INVESTIGATION AND DESIGN OF WATER SUPPLY,
SEWAGE DISPOSAL AND MUNICIPAL IMPROVEMENTS.

Laying Water Mains in Alleys.

By C. R. Henderson, Manager Davenport Water Works Co., Davenport, Iowa.

The plan of laying water mains, gas mains, sewers, steam mains, telephone conduits and all other underground structures, used for the service of the public, in the alleys instead of in the streets is frequently advocated and sometimes tried.

Arguments in Favor of Mains in Alleys

The principal reason given by advocates of the plan is that by laying mains in alleys the streets will be opened less frequently and consequently pavements will be less often disturbed. This is a very good reason, for we will all agree that it is seemingly impossible to replace pavements so as to avoid bumps and holes. It can be done by skillful and conscientious workmen, in the case of first class pavements, although the poorer the class of pavement the more difficult the job of replacement.

Other Utility Lines in Alleys

The laying of conduits in alleys for light, power, telephone and telegraph lines, is frequently adopted and seems to be practical in certain districts. Sanitary sewers might often be laid in alleys but where combination or storm water sewers are required the difficulty increases because catch basins must be provided at street intersections.

Of course it is true that nowadays alleys are paved as well as streets, and that there is as much difficulty about replacing the pavement in an alley as in a street, but alleys are not used for fast driving so much as are streets, and the scars made by excavation would not be so prominent in alleys as in streets.

Objections to Use of Alleys for Water Mains

The principal objection to the alley is that it is not wide enough to accommodate all the underground work and that alleys, as usually laid out, are not continuous and usually run in one direction only.

Gas mains and water mains, but especially water mains, must be laid as a gridiron, crossing frequently at right angles, and this is seldom possible if alleys are used exclusively.

Water mains supply fire hydrants which are necessary and are usually, and properly, located at street intersections. As an example: The commercial district of Davenport is covered by a perfect gridiron of good size mains. All the alleys in this district run east and west. If the mains were laid in these alleys the north and south mains would have to be laid in streets. In such case hydrants at street intersections would be on one main only while alley hydrants, which are less numerous, would be near intersecting mains.

Hydrants are also required halfway between street intersections on east and west streets as well as north and south streets and if mains were laid in alleys these hydrants would have to be eliminated as there would be no space in which to set them in our 20 ft. alleys.

A few years ago the writer tried to lay a small water main in an alley because it was desirable to avoid cutting a new pavement. There were several conduits in this alley used by telephone, telegraph and electric power companies and at the entrance of the alley were three manholes of considerable size. The water pipe could not be laid between the manholes because they overlapped. It could not be laid through them because the companies owning them objected, and it could not be laid under them because the ground was solid rock and blasting would disturb the conduit system. The new pavement was cut and the pipe was not laid in this alley.

Gas and water services require shut off cocks and curb boxes for outside control, and these are best located on sidewalks if they are to be accessible when needed.

Curb boxes should always be located on public property.

American Cast Iron Pipe Company

MANUFACTURERS OF

CAST IRON PIPE & FITTINGS

BIRMINGHAM, ALA.

SALES OFFICES:

Birmingham, Ala.	Box 908.
Columbus, Ohio	607 New Hayden Building.
Minneapolis, Minn.	712 Plymouth Building.
New York City	No. 1 Broadway.
Chicago, Ill.	512 First National Bank Building.
Dallas, Texas	1217 Praetorian Building.
Kansas City, Mo.	716 Scarritt Building.
San Francisco, Cal.	711 Balboa Building.
Los Angeles, Cal.	339 Citizens National Bank Building.

DIRECT OXIDATION PROCESS

Apparatus for carrying out this Process for Sewage and Water Treatment supplied upon Engineers' specifications.

Direct Oxidation Process Corporation

15th and Lehigh Ave. Philadelphia, Pa.

STEWART SEWER CLEANING MACHINE

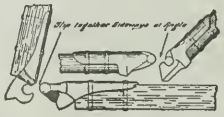
Water Cleaning System if you wish it, or Drag Bucket type.

Also have TURBINE SEWER CLEANING MACHINE at Low Price.

WE WILL PAY FREIGHT AND CHARGE TO BILL.

We Ship Rods for Trial—who else will do this?

We also make a Rod that will float. Also Rods with wheels for conduit work.



SEWER AND CONDUIT RODS

No Deep Shoulder Cut for Couplings—Rods retain full size and strength

Investigate our JUMBO ROD

W. H. STEWART

1614 Locust Street - - ST. LOUIS, MO.

129 George Street - - - BOSTON, MASS.

CANADA FACTORY, WALKERVILLE, ONT.

THEREFORE NO DUTY FOR PURCHASER TO PAY

PACIFIC COAST DELIVERIES MADE FROM SAN FRANCISCO.

When located in alleys heavy vehicles are likely to pass over them and break them. It is not desirable to place a curb box at any point where it may be covered by ash barrels, manure boxes or other material.

When locating a meter in a commercial district the front entrance to a building is superior to the rear entrance in most cases.

In existing residential districts the same objection above mentioned regarding the width of alleys and that they usually run in one direction only, and not continuously, applies. In new additions provisions could be made so long as one policy prevailed, but then mains running at right angles to the prevailing direction of the alleys would have to be laid in streets.

. When blocks are 500 to 800 ft. between cross streets, sufficient hydrants would not be possible for proper protection, conveniently located, when mains were in alleys.

Alley Location of Water Mains Proved Impractical at Davenport

In two cases the plan of laying water mains in alleys has been tried in new additions in Davenport. In one case, a high class residence district, private rights of way had to be provided for hydrant branches, also for some mains, in order to complete the lay out. One 8 in. main in this district now lies very deep under a brick wall and other expensive improvements in the yards of fine houses. The alley was vacated in this case. Parts of the district were platted without alleys and mains were laid in the streets, necessarily.

In another district, houses were built facing, and on each side of a wide boulevard. The water mains were laid in the alleys behind each row of houses. This plan worked all right until houses were built on the far side of one of the next parallel streets when mains had to be provided for them. There being no alley, the main was laid in the street, and we now have parallel mains one half block apart.

In one Iowa City the principal main was laid through the alleys of the commercial district. Fire hydrants located at t street intersections were supplied from this main by long branches of smaller pipe. These long hydrant branches added to the expense of the system, added to the loss of head between the main and the hydrant, and there being no flow in the pipe between the main and hydrant, the danger of freezing would naturally be greater than in a normal installation.

The writer is willing to concede that the alleys could be utilized for some utilities—probably wiring and sanitary sewers—but contends that water mains for reasons applying to safety and economy had best be laid in the streets.

The foregoing paper was presented at the recent annual meeting of the Iowa section of the American Water Works Association.

Loosening Hard Soil in Water Pipe Line Trench Without Picking

By Charles F. Higgs.

We were digging a ditch four miles long in which to lay a water supply pipe line from the source of supply to a town which was to have water service. We encountered rock and many types of soil along the right of way and were using dynamite to dispose of the rock. The soil in many places was so hard that much laborious picking was necessary to loosen it and the time consumed in doing this was greatly delaying the completion of the work.

Blasting Suggested

It was suggested that dynamite could be used also to loosen this hard soil thus reducing, and in some cases, altogether obviating the pick. The foreman of the job, however, had never heard of using dynamite for hard soil and expressed the opinion that the blasting would throw the dirt so far away

ACME
Manholes, Catch Basins, Inlet Basins, Park Basins (All Styles)
REGULAR AND SPECIAL GRATES OR STRAINERS FOR SEWER PIPE.

BUILDING COLUMNS OF ALL DESCRIPTIONS
SEND US YOUR SPECIFICATIONS
MADISON FOUNDRY CO.
927 Addison Road, CLEVELAND, OHIO.

WM. E. DEE COMPANY
30 North La Salle Street, CHICAGO, ILL.

WE MANUFACTURE
D & D Safety Cover
GUARANTEED NOT TO RATTLE OR DISH
Patent Numbers 965163-1177850
Full Line of MANHOLE and CATCH BASIN COVERS of all Kinds.
WRITE FOR OUR PRICES

What do You Want to Buy?
If you want to be relieved of the annoyance of extensive correspondence and calls from salesmen who do not understand your needs, just write a brief letter to us stating your requirements and we shall immediately place you in touch with the manufacturer best qualified to serve you.
Municipal and County Engineering
538 S. Clark St. CHICAGO, ILL.

MUNICIPAL CASTINGS
Catalog on request.

Send us your Specifications.
Ellwood Foundry, Gray Iron Castings Ellwood City, Pa.

from the ditch that it would not be available for filling in over the pipe.

I expressed the opinion that this could be avoided by using charges only large enough to loosen the soil but not large enough to throw it out as would be done if a ditch were being blasted. It was decided to try this experiment.

Blasting Proves Successful.

The tools required were 10 lb. sledge hammers and a steel drive point 1½ ins. in diameter. The sledges were used to drive the steel bar into the ground making the holes 2 ft. deep in which the charges of dynamite were loaded.

The holes were spaced 4 ft. apart, each hole being loaded with ¼ lb. of 40% dynamite well tamped in. As we had no blasting machine, a blasting cap and length of fuse was inserted in each charge. The charge being small, a man could go along the line of charges lighting the fuses without risking any danger from the blasts going off 40 or 50 ft. behind him.

The experiment was an entire success and the method was adopted for digging the three miles of ditch uncompleted at the time the experiment was made.

These small blasts loosened the hard ground very nicely. It was possible to shovel out most of the dirt without any picking whatever.

Because of the time of labor saved by the blasting, the cost of the work was greatly reduced and the time of completion of the job decidedly shortened.

Advantages of State Supervision of Water Works

By Frederic Bass, Professor of Civil Engineering, University of Minnesota, Minneapolis, Minn.

The English Reform Bill of 1832 brought municipal government into question. An investigation followed which revealed a situation corrupt far beyond that ever witnessed in any American city and resulted in legislation which finally placed many supervisory powers in the hands of the central or national government. Among the agencies now exercising these central powers is the Local Government Board which has the power to issue regulations having the force of law governing many municipal activities, including relief of the poor, public health and sanitation, fixing of boundaries, municipal borrowing and others. The purpose of this Board is to harmonize and promote the correct functioning of many municipal activities. It does not initiate or expand or directly supervise projects, but supplies expert studies and investigations such as the State Boards of Health in America do in regard to public water supplies, sewerage and public works of a sanitary nature, or as State Public Utility Commissions do in regard to certain public utilities.

There are many municipal problems of construction which may or may not involve sanitary questions which are of vital

WM. E. DEE CLAY MFG. CO.
Proprietors of MECCA CLAY WORKS
MANUFACTURERS OF
STANDARD AND DOUBLE STRENGTH
Sewer Pipe, Drain Tile, Culvert Pipe, Well Tubing, Flue Lining, Wall Coping and Fire Brick.
WORKS { Mecca, Parke County, Ind., on C. & E. I. R. R. / Newport, Vermillion County, Ind., on C. & E. I. R. R.
Chicago Office, 30 N. LaSalle St.

SEWER PIPE OF QUALITY
Made of a SUPERIOR QUALITY of FIRE CLAY in the Finest Plant in the West.
The pipe that WON THE TEST for crushing strength before the Louisville Sewer Commission, showing an average CRUSHING STRENGTH OF 43 PER CENT HIGHER than competitors' samples. Just a little better than the rest. Write us today for particulars.
CANNELTON SEWER PIPE CO. . . Cannelton, Ind.

SEWER PIPE
Segment Sewer Block, Drain Tile, Hollow Building Block, Flue Lining, Wall Coping, Etc.
LEWIS McNUTT
28 South Walnut St. BRAZIL, INDIANA.
Our Special Feature is anything in the Clay Goods Line in mixed or straight cars.
Clay Products

SLUICE GATES
Shear, Flap and Butterfly Valves
FLEXIBLE JOINTS
COLDWELL-WILCOX CO.
South Water Street NEWBURGH, N. Y.

BEST EXTENSIBLE TRENCHING BRACE MADE
KALAMAZOO F'DRY & MACHINE CO. MICHIGAN
594 EAST MAIN STREET.

interest not only to the municipalities immediately concerned but also to their commercially tributary area, and in some cases to the entire state in which they are situated. Among these are the standards of service which public water supplies shall meet.

A State Board of Health may compel a municipality to cut off a cross-connection to an auxiliary polluted water supply which is used only in emergencies at times of fire. It is quite correct for it to do so. But there is no authority nor any official state board to compel or advise a city to provide for means of fire protection by storage, increased pumping capacity or otherwise, and while the city has gained protection against disease it may have lost it against fire. It may be said that a communicable disease will not stop at city limits and therefore control of sanitary conditions is required, it is also true that a disastrous fire in any city is a damage to its whole tributary trade area; the principle of state interest in the standards of protection is the same in both cases.

The Fire Hazard

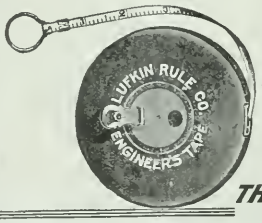
Fire insurance companies have combined to standardize public waterworks so far as fire protection equipment is concerned in order that their insurance rates might be equalized. But the fire hazard is not impressed upon the city authorities as is the disease hazard, with the result that we see the great majority of small cities and villages without adequate fire protection, protection which would be warranted from an economic standpoint. The cure for this condition would be an efficient scientific supervision of water supplies by a state body which would concern itself not only with the sanitary features of design and operation but also those which are of a structural and economic nature, thus dealing with the entire unit. Such a board could do all that the State Board of Health could do and much more to the benefit of the local community. Since the province of public health has been within recent years sharply specialized, and many expert sanitary engineers are available whose judgment on sanitary, economic and structural features of water works is of the highest character, it would seem that state supervision of public water supplies might better be vested in a board similar to that of the Local Government Board of England, which might review public works in their entirety.

To reinforce this suggestion it might be stated that such a board would find a large usefulness to the cities in giving general advice in regard to other public improvements such as public buildings, pavements and city planning. Probably advice in regard to municipal finance would be one of the most valuable functions of a State Board of Public Works, but the point here emphasized is that public water supplies should be standardized on the basis of fire protection by a public agency.

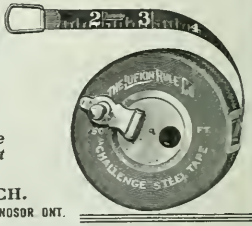
Faultless Service in Every Respect

THAT'S WHAT YOU NEED WHEN TAKING MEASUREMENTS

That's what you can rest assured you are getting when you use



LUFKIN TAPES



PIONEERS IN CONNECTION WITH THE NOTEWORTHY IMPROVEMENTS MADE IN TAPES

More of them are in use than all other makes because they have for years consistently maintained the highest reputation. Send for Catalog No. 26.

THE LUFKIN RULE CO. SAGINAW, MICH.

NEW YORK LONDON, ENG WINDSOR ONT.

LABORERS and TRADESMEN
CARPENTERS, HANDY MEN

100% free of charge to employers

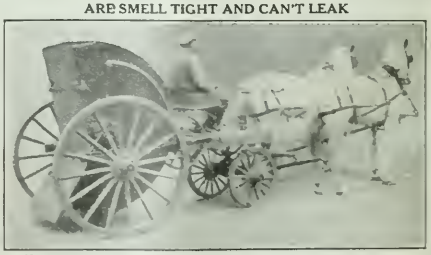
Sewer, Street, Road and Factory Men
Foreign and American Laborers

Diamond Labor Agency

557 W. Madison St. CHICAGO, ILL.

Phone Main 5074

HOLZBOG SANITARY CARTS AND WAGONS
ARE SMELL TIGHT AND CAN'T LEAK



These vehicles supplied with either two or four wheels, for one or two horses. *Write for literature.*

GEO. H. HOLZBOG & BRO. - Jeffersonville, Indiana

CHLORIDE OF LIME

FOR PURIFYING WATER

PENNSYLVANIA SALT MANUFACTURING CO.

115 Chestnut Street, PHILADELPHIA, PA.

This Water Works Section is a Regular Feature of

Municipal and County Engineering

Published Monthly at

538 S. Clark St. Chicago, Ill.

Subscription price for the Full Number, $2.00 per year.